COMMONWEALTH MYCOLOGICAL INSTITUTE
6 SEP 1962

THE REVIEW OF APPLIED ENTOMOLOGY

SERIES B: MEDICAL AND VETERINARY

VOL. 48
(1960)

ISSUED BY THE COMMONWEALTH INSTITUTE OF ENTOMOLOGY

LONDON:
COMMONWEALTH INSTITUTE OF ENTOMOLOGY,
56, QUEEN'S GATE, S.W.7

1961

Commonwealth Agricultural Bureaux

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ERRATA

Page 25 15 lines from end for " S-ethoxycarbonylethyl " read " S-2-(ethoxycarbonyl)ethyl "

,, ,, 15–14 lines from end for " S-1-(2-methoxycarbonyl)propyl " read " S-2-(methoxycarbonyl)propyl "

,, ,, 12 lines from end for " S-methoxycarbonyl " read " S-carboxymethyl "

,, ,, 6 lines from end for " S-ethoxycarbonylethyl " read " S-2-(ethoxycarbonyl)ethyl "

,, 68 7 lines from end for " -6-pyrimidinyl) phosphorothioate " read " -6-pyrimidinyl phosphorothioate) "

,, 114 line 27 for " *hippopotamensis* " read " *hippopotamense* "

,, 131 line 3 for " J. H. C. Gear " read " J. H. S. Gear "

,, 164 17 lines from end for " -coumarinyl " read " -7-coumarinyl "

,, 169 3 lines from end for " *dubias* " read " *dubius* "

,, 172 line 10 for " **41** 157 " read " **41** 156 "

COMMONWEALTH INSTITUTE OF ENTOMOLOGY.

REVIEW
OF
APPLIED ENTOMOLOGY.

SERIES B.

Vol. 48. 1960.

EDITORIAL

THE NOMENCLATURE OF CHEMICALS USED IN PEST CONTROL

Since the earlier list of names for chemicals used in pest control was published in this *Review* [*cf. R.A.E.*, B **41** 1–3], the number of common names made available for such materials has increased considerably. Notable contributions have been made in Britain in British Standard 1831: 1957 and in its supplements No. 1 (1959) and No. 2 (*in press*) and in the United States in the list of insecticides compiled by the Committee on Insecticide Terminology of the Entomological Society of America and published in the *Journal of Economic Entomology* **50** (1957) pp. 226–228, with additions in **51** (1958) p. 373, and in the list of fungicides published in *Phytopathology* **45** (1955) pp. 295–302.

To enable full advantage of these developments to be taken in the *Review*, a revised and expanded list is presented of the names for chemicals that will be used in abstracts without further chemical definition unless special considerations render this undesirable. When the name used in the *Review* differs substantially from a common or proprietary name used by the author of the paper abstracted, the latter will also be indicated. In addition to insecticides and acaricides, a few fungicides and other materials are now included. The arrangement follows the earlier model, and names marked by " a " are approved by the Committee of the Entomological Society of America, names marked by " b " are adopted in the British Standard (with its supplements), those marked by " c " have been adopted by the U.S. Interdepartmental Committee on Pest Control, and those marked " d " are cited in the list in *Phytopathology*.

When additions to the list or changes in it become desirable, they will be announced in the *Review*.

Common name used	Chemical names or definitions	Other names
aldrin [a,b,c]	not less than 95 per cent. HHDN [*q.v.*]	
allethrin [a,b,c] ..	*dl*-2-allyl-4-hydroxy-3-methyl-2-cyclopenten-1-one esterified with a mixture of *cis* and *trans dl*-chrysanthemic acids	allyl homologue of cinerin I, synthetic pyrethrins
amiton [b]	O,O-diethyl S-2-(diethylamino)ethyl phosphorothioate	
amiton oxalate ..	hydrogen-oxalate salt of amiton [*q.v.*]	Chipman R-6199 [a]
BHC [a,b]	1,2,3,4,5,6-hexachlorocyclohexane benzene hexachloride (BHC is used for a mixture of isomers; the British Standard requires that the percentage of γ BHC be stated.)	HCH, 666
α BHC, β BHC, γ BHC, etc.	individual isomers of the above	
bromo-DDT ..	a complex chemical mixture in which p,p′bromo-DDT [*q.v.*] predominates	
p,p′bromo-DDT	1,1-di(p-bromophenyl)-2,2,2-trichloroethane	
Bulan [a]	1,1-di(p-chlorophenyl)-2-nitrobutane	
butonate	O,O-dimethyl 2,2,2-trichloro-1-n-butyryloxyethylphosphonate	
captan [b,d] ..	N-(trichloromethylthio)-4-cyclohexene-1,2-dicarboximide	
chlorbenside [b] ..	p-chlorobenzyl p-chlorophenyl sulphide	Chlorbenside [a], Chlorparacide
chlordane [a,b,c] ..	1,2,4,5,6,7,10,10-octachloro-4,7,8,9-tetrahydro-4,7-*endo*methyleneindane 1,2,4,5,6,7,8,8-octachloro-2,3,3a,4,7,7a-hexahydro-4,7-methanoindene	
chlorfenson [b] ..	p-chlorophenyl p-chlorobenzenesulphonate	ovex [a], Ovotran, CPCBS
chlorobenzilate [b] ..	ethyl p,p′-dichlorobenzilate	Chlorobenzilate [a]
Chlorthion [a] ..	O,O-dimethyl O-3-chloro-4-nitrophenyl phosphorothioate	
chrysanthemic acid	chrysanthemum monocarboxylic acid	chrysanthemumic acid
cyclethrin [a] ..	*dl*-2-(2-cyclopentenyl)-4-hydroxy-3-methyl-2-cyclopenten-1-one esterified with a mixture of *cis* and *trans dl*-chrysanthemic acids	
DDA	di(p-chlorophenyl)acetic acid	
DDD	a complex chemical mixture in which p,p′DDD [*q.v.*] predominates	TDE [a]
p,p′DDD ..	1,1-di(p-chlorophenyl)-2,2-dichloroethane	
DDE	1,1-di(p-chlorophenyl)-2,2-dichloroethylene	

Common name used	Chemical names or definitions	Other names
DDT [a,b]	a complex chemical mixture in which p,p′DDT [*q.v.*] predominates (The British Standard requires the percentage of p,p′DDT to be stated.)	dicophane, B.P. (75 per cent. p,p′DDT) chlorophenothane, U.S.P. (14 : 136. 1950)
p,p′DDT [b] ..	1, 1 - di (p - chlorophenyl) - 2, 2, 2 - trichloro - ethane	
demeton [a,b] ..	a mixture of demeton-O and demeton-S [*q.v.*]	
demeton-O [b] ..	O,O-diethyl O-2-(ethylthio)ethyl phosphorothioate	
demeton-S [b] ..	O,O-diethyl S-2-(ethylthio)ethyl phosphorothioate	
diazinon [b] ..	O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl phosphorothioate	Diazinon [a]
dicapthon [a] ..	O,O-dimethyl O-2-chloro-4-nitrophenyl phosphorothioate	Am. Cyanamid 4124
dichlorvos [b] ..	dimethyl 2,2-dichlorovinyl phosphate	DDVP [a]
dieldrin [a,b,c] ..	not less than 85 per cent. HEOD [*q.v.*]	
dimefox [a,b] ..	bis(dimethylamino)fluorophosphine oxide	Hanane, Pestox 14
dimetan [a]	dimethyl 3-hydroxy-5,5-dimethyl-1-oxo-2-cyclohexenyl carbamate 5,5-dimethyldihydroresorcinol dimethylcarbamate	
dimethoate ..	O,O - dimethyl S - methylcarbamoylmethyl phosphorodithioate	Rogor
dimethyl carbate [a]	dimethyl ester of *cis*-bicyclo[2.2.1]-5-heptene-2,3-dicarboxylic acid	
dinex [b]	2,4-dinitro-6-cyclohexylphenol The British Standard recommends that salts or esters of this compound should be differentiated by the addition, following a hyphen, of the name of the combining substance, *e.g.*, dinex-sodium.	dinitrocyclohexylphenol [a],DNOCHP
dinosam [b]	2,4-dinitro-6-sec.-amylphenol Salts or esters to be cited as indicated under dinex.	
dinoseb [b]	2,4-dinitro-6-sec.-butylphenol Salts or esters to be cited as indicated under dinex.	dinitrobutylphenol [a]
DMC	1,1-di(p-chlorophenyl)ethanol di(p-chlorophenyl)-methyl-carbinol	Dimite [a]
DNC	3,5-dinitro-o-cresol [numbered with CH_3 as 1] 4,6-dinitro-o-cresol [numbered with OH as 1] Salts or esters to be cited as indicated under dinex.	DNOC [b], dinitrocresol [a]

Common name used	Chemical names or definitions	Other names
endothion [b] ..	2-(O,O-dimethyl phosphorothiolomethyl)-5-methoxy-4-pyrone	
endrin [a,b,c] ..	1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,-5,6,7,8,8a-octahydro-*exo*-1,4-*exo*-5,8-dimethanonaphthalene, according to the nomenclature of the Chemical Society, London 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,-5,6,7,8,8a-octahydro-*endo*-1,4-*endo*-5,8-dimethanonaphthalene, according to the nomenclature of the American Chemical Society	
EPN [a]	O-ethyl O-p-nitrophenyl phenylphosphonothioate	
ethion [a,b]	tetra-O-ethyl S,S′-methylene bisdithiophosphate O,O,O′,O′-tetraethyl S,S′-methylene bisphosphorodithioate	Nialate
ethyl-DDD ..	a complex chemical mixture in which p,p′-ethyl-DDD [*q.v.*] predominates	Perthane [a], Q-137
p,p′ethyl-DDD	1,1-di(p-ethylphenyl)-2,2-dichloroethane	
ethyl hexanediol [a]	2-ethyl-1,3-hexanediol	Rutgers 612
fenson [b]	p-chlorophenyl benzenesulphonate	PCPBS, CPBS
ferbam [b,d]	ferric dimethyldithiocarbamate	
fluorbenside [b] ..	p-chlorobenzyl p-fluorophenyl sulphide	
fluoro-DDT ..	a complex chemical mixture in which p,p′-fluoro-DDT [*q.v.*] predominates	
p,p′fluoro-DDT	1,1-di(p-fluorophenyl)-2,2,2-trichloroethane	DFDT
furethrin [a] ..	*dl*-2-(2-furfuryl)-4-hydroxy-3-methyl-2-cyclopenten-1-one esterified with a mixture of *cis* and *trans dl*-chrysanthemic acids	
Genite [a]	2,4-dichlorophenyl benzenesulphonate	
glyodin [d]	2-heptadecyl-2-imidazoline acetate	
Guthion [a]	O,O-dimethyl S-(4-oxo-benzotriazino-3-methyl) phosphorodithioate	Gusathion, Bayer 17147
HEOD [b]	1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,-5,6,7,8,8a-octahydro-*exo*-1,4-*endo*-5,8-dimethanonaphthalene, according to the nomenclature of the Chemical Society, London 1,2,3,4,10,10-hexachloro-6,7-epoxy-1,4,4a,-5,6,7,8,8a-octahydro-*endo*-1,4-*exo*-5,8-dimethanonaphthalene, according to the nomenclature of the American Chemical Society	
heptachlor [a,b,c] ..	1(or 9),4,5,6,7,10,10-heptachloro-4,7,8,9-tetrahydro-4,7-*endo*methyleneindene 1(or 3a),4,5,6,7,8,8-heptachloro-3a,4,7,7a-tetrahydro-4,7-methanoindene	

Common name used	Chemical names or definitions	Other names
HHDN [b]	1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-*exo*-1,4-*endo*-5,8-dimethanonaphthalene, according to the nomenclature of the Chemical Society, London 1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-*endo*-1,4-*exo*-5,8-dimethanonaphthalene, according to the nomenclature of the American Chemical Society	
isodrin [a,b,c] ..	1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-*exo*-1,4-*exo*-5,8-dimethanonaphthalene, according to the nomenclature of the Chemical Society, London 1,2,3,4,10,10-hexachloro-1,4,4a,5,8,8a-hexahydro-*endo*-1,4-*endo*-5,8-dimethanonaphthalene, according to the nomenclature of the American Chemical Society	
Isolan [a]	1-isopropyl-3-methyl-5-pyrazolyl dimethylcarbamate	
Karathane [a] ..	2,4-dinitro-6-(1-methylheptyl)phenyl crotonate	
Kelthane [a] ..	1,1-di(p-chlorophenyl)-2,2,2-trichloroethanol	
lindane [a,c] ..	γ isomer of BHC [*q.v.*] of not less than 99 per cent. purity	
malathion [a,b,c] ..	O,O-dimethyl S-(1,2-di(ethoxycarbonyl)ethyl) phosphorodithioate	
maneb [b,d]	manganese ethylene-1,2-bisdithiocarbamate	
mazidox [b] ..	bis(dimethylamino)azidophosphine oxide	
methoxy-DDT ..	a complex chemical mixture in which p,p′-methoxy-DDT [*q.v.*] predominates	dianisyl trichloroethane
p,p′methoxy-DDT	1,1-di(p-methoxyphenyl)-2,2,2-trichloroethane	methoxychlor [a,b,c]
methyl-DDT ..	a complex chemical mixture in which p,p′-methyl-DDT [*q.v.*] predominates	ditolyl trichloroethane
p,p′methyl-DDT	1,1-di(p-methylphenyl)-2,2,2-trichloroethane	
methyl-demeton	a mixture of methyl-demeton-O and methyl-demeton-S [*q.v.*]	Metasystox, demeton-methyl [b]
methyl-demeton-O	O,O-dimethyl O-2-(ethylthio)ethyl phosphorothioate	demeton-O-methyl [b]
methyl-demeton-S	O,O-dimethyl S-2-(ethylthio)ethyl phosphorothioate	demeton-S-methyl [b]
methyl-parathion	O,O-dimethyl O-p-nitrophenyl phosphorothioate	parathion-methyl [b]
mipafox [b]	bis(monoisopropylamino)fluorophosphine oxide	Pestox 15, Isopestox
nabam [b,d] ..	disodium ethylene-1,2-bisdithiocarbamate	
Neotran [a]	di(p-chlorophenoxy)methane	

Common name used	Chemical names or definitions	Other names
paraoxon ..	diethyl p-nitrophenyl phosphate	E-600, para-oxon [a]
parathion [a,b,c] ..	O,O-diethyl O-p-nitrophenyl phosphorothioate	E-605
phenkapton [b] ..	O,O-diethyl S-2,5-dichlorophenylthiomethyl phosphorodithioate	
phorate [b]	O,O-diethyl S-ethylthiomethyl phosphorodithioate	Thimet [a]
Phosdrin [a] ..	dimethyl 2-methoxycarbonyl-1-methylvinyl phosphate	
phosphamidon [b] ..	dimethyl 2-chloro-2-diethylcarbamoyl-1-methylvinyl phosphate	
piperonyl butoxide [a]	product containing as its principal constituent α-[2-(2-butoxyethoxy)-ethoxy]-4,5-methylenedioxy-2-propyltoluene	
piperonyl cyclonene [a]	mixture of 3-alkyl-6-carbethoxy-5-(3,4-methylenedioxyphenyl)-2-cyclohexen-1-one and 3-alkyl-5-(3,4-methylenedioxyphenyl)-2-cyclohexen-1-one	
Pirazinon [a] ..	O,O-diethyl O-2-propyl-4-methyl-6-pyrimidinyl phosphorothioate	
Potasan [a]	O,O-diethyl O-4-methyl-7-coumarinyl phosphorothioate	
Prolan [a]	1,1-di(p-chlorophenyl)-2-nitropropane	
propyl isome [a] ..	di-n-propyl 6,7-methylenedioxy-3-methyl-1,-2, 3, 4-tetrahydronaphthalene-1,2-dicarboxylate	n-propyl isome
Pyrazothion ..	O,O-diethyl O-3-methyl-5-pyrazolyl phosphorothioate	
Pyrazoxon ..	diethyl 3-methyl-5-pyrazolyl phosphate	
pyrethric acid ..	chrysanthemum dicarboxylic acid monomethyl ester	
Pyrolan [a]	1-phenyl-3-methyl-5-pyrazolyl dimethylcarbamate	
schradan [a,b] ..	bis(dimethylamino)phosphonous anhydride octamethyl pyrophosphoramide	OMPA
sesamex [a]	2-(2-ethoxyethoxy)ethyl-3,4-methylene-dioxyphenyl acetal of acetaldehyde	Sesoxane
Sevin	1-naphthyl N-methylcarbamate	7744
siglure [a]	sec.-butyl 6-methyl-3-cyclohexene-1-carboxylate	
Strobane [a] ..	a mixture of chlorinated terpenes with a chlorine content of about 66 per cent.	
sulfotep [b]	tetraethyl dithionopyrophosphate	sulfotepp [a]

Common name used	Chemical names or definitions	Other names
sulfoxide [a] ..	1,2-methylenedioxy-4-[2-(octylsulphinyl)-propyl]benzene	
Tedion [a]	2,4,5,4′-tetrachlorodiphenyl sulphone	
TEPP [a,b]	tetraethyl pyrophosphate	
Thanite [a] ..	mixture of fenchyl and isobornyl thiocyanoacetates	
Thiodan [a]	6,7,8,9,10,10 - hexachloro - 1,5,5a,6,9,9a-hexahydro - 6, 9 - methano - 2,4,3 - benzodioxathiepin-3-oxide	
thiometon [b] ..	O,O-dimethyl S-2-(ethylthio)ethyl phosphorodithioate	Ekatin
thiram [b,d] ..	bis(dimethylthiocarbamoyl) disulphide	
toxaphene [a,b,c] ..	chlorinated camphene having a chlorine content of 67–69 per cent.	
trichlorphon [b] ..	dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate	Dipterex [a]
Trithion [a]	O,O-diethyl S-p-chlorophenylthiomethyl phosphorodithioate	
zineb [b,d]	zinc ethylene-1,2-bisdithiocarbamate	
ziram [b,d]	zinc dimethyldithiocarbamate	

Proceedings of the Tenth International Congress of Entomology, Montreal, August 17–25, 1956. Section on medical and veterinary entomology.—*Proc. 10th int. Congr. Ent.* **3** pp. 495–892. Ottawa, 1958.

The following are abstracts of selected papers containing hitherto unpublished information of which the text is printed in full in this section [*cf. R.A.E.*, B **47** 97].

Kershaw (W. E.). **The population dynamics of infection with *Onchocerca volvulus* in the vector *Simulium damnosum***, pp. 499–501, 3 refs. The following is substantially the author's abstract. In light or moderate infections with West African onchocercosis (caused by *Onchocerca volvulus*), the microfilariae are largely concentrated in the skin of the ankles and calves and then of the buttocks, and few or absent in the trunk, head, neck and arms [*cf.* **44** 10]. *Simulium damnosum* Theo. bites in greatest numbers on the ankles and calves [*cf.* **45** 19]. In an advanced case of onchocercosis, when the skin of the ankles and calves becomes fibrosed, the microfilariae under the surface become fewer and transmission from host to vector is suppressed. From a study of the numbers of *S. damnosum* taking up different numbers of microfilariae from cases of different intensities of infection, it is concluded that a case with moderate infection is a better reservoir than a lightly infected one, and that a case of advanced infection is the least effective reservoir. The length of life of the Simuliids is not significantly influenced by the development of the microfilariae. These are ingested by the fly with its blood-meal, and though many become

included within the peritrophic membrane, which is rapidly formed round the meal, some may escape. Those within the membrane presumably perish during digestion, but the others develop in the thoracic muscles, and when fully developed are found in the head, antennae and legs. The population of microfilariae ingested by the fly falls progressively but irregularly after the first two days of larval development. In the laboratory, about a tenth survive to the infective stage, and, as about half the Simuliids survive long enough for infective forms to arise in them, about a twentieth complete their development.

Bertram (D. S.). **Experimental epidemiology with the filarioid infection of cotton rats,** pp. 503–506, 9 refs. The following is largely the author's abstract. Several forms of filiariasis, transmitted by mosquitos or other blood-sucking Diptera, affect man in the tropics. Filarioid infections are also known from a wide range of animals and birds, but little is known about their vectors, except for the mosquito-borne filariases of dogs and the mite-borne filariasis of cotton rats [*Sigmodon hispidus*]. The existence of cotton-rat filariasis (caused by *Litomosoides carinii*) has made it possible to carry out quantitative investigations of the inter-relations of host, parasite and vector. Initial work [*cf.* **37** 140] concerned cotton rats infected once only with different numbers of worms, the ensuing infections, their infectivity for the mite vector *Ornithonyssus bacoti* (Hirst), and the vector efficiency of the mite. Investigations were then extended to the more complex results of reinfection, artificial epizootics being arranged under laboratory conditions. Prolonged exposure to reinfection resulted in cotton rats of subnormal weight, with considerable infections with adult worms, but since few or no microfilariae occurred in the blood-stream, the continuity of transmission was jeopardised or disrupted. With intermittent transmission, the cotton rats were of normal weight, considerable infections with adult worms were again evident, microfilarial infection of the blood was extremely high and remained so for months, and transmission was assured, although less intensively than might be supposed. These two patterns are contrasting cases of an infinitely variable quantitative relation between the host, parasite and vector. They suggest that marked seasonal transmission, as opposed to transmission throughout the year, might be important in the apparent incidence and the epidemiology of, at least, cotton-rat filariasis, if not of other infections in other hosts.

Scott (J. A.). **Maintenance of the tropical rat mites and the quantitative transmission of cotton rat filariae,** pp. 507–508, 6 refs. The following is largely based on the author's abstract. Improvements have been effected in the methods by which colonies of *Ornithonyssus* (*Bdellonyssus*) *bacoti* (Hirst) are maintained continuously on white rats and the mites infected with *Litomosoides carinii* [*cf.* **38** 211]. Provision was made for the inspection of the rat and for supplying food without opening the container. At the end of three weeks, the rat was transferred with the attached mites to a new unit, and the remaining mites were removed from the bedding material by means of a heating apparatus and the nymphs so obtained returned to the rat to hasten the development of the colony. The adults were kept at a temperature of 22°C. [71·6°F.] for a week, allowed to feed on a cotton rat [*Sigmodon hispidus*] infected with *L. carinii*, again isolated and kept at a constant temperature and a high relative humidity for 2–3 weeks. Nearly all the larval filariae developed to the infective stage in about 18 days. The mites were then dissected, and the infective larvae were removed, counted and introduced into a subcutaneous pocket excavated in the flank of an experimental cotton rat, or into the abdominal cavity. In this way, precise quantitative infections were possible. The methods proved satisfactory for use in studies of immunity in cotton rats due to recent infections.

Barnley (G. R.). **Control of *Simulium* vectors of onchocerciasis in Uganda,** pp. 535–537, 5 refs. Surveys in Uganda showed that *Simulium damnosum* Theo., the breeding of which was confined to a 42-mile reach of rapids in the Victoria Nile near Lake Victoria, infested an area of about 3,000 sq. miles and that onchocercosis [caused by *Onchocerca volvulus*] was widespread in this area; the whole of the adult population in communities within 10 miles of the river was infected, as shown by a single skin snip biopsy. In a preliminary experiment on the control of the Simuliid [*cf.* **43** 206, etc.], a solution of 10 per cent. DDT in oil was applied from the air to the marginal vegetation at a rate of 20 mg. per sq. metre in 3 five-yard swathes, one along each bank of a six-mile course and the third over the central islands, and 11 sorties at three-day intervals were planned. A very significant decrease in the number of adult Simuliids was apparent after the first application, and a significant diminution of density was noticeable throughout the whole of the infested area. There was also a marked larvicidal action for several miles downstream from the reach sprayed, as a result of DDT solution that had fallen on the water. The concentration of DDT so applied would have been of the order of 1 part in 40 million parts water, maintained for 30 minutes. These results and the hazards of operating aircraft in the area led to the adoption of a larvicidal campaign. On 3rd June 1952, the first of 12 weekly applications calculated to give a concentration of one part DDT in 2½ million parts water for 30 minutes was made, from a motor-launch equipped with a fire-fighting pump that had been modified in such a way as to project an emulsified solution some 80 ft. No living *Simulium* larvae could be found at any previously stocked breeding site on the entire 42-mile stretch 48 hours after the first application, and the adult fly count had declined from over 100 per boy-hour to zero after the third. Thereafter no adults were captured until a single one appeared on 16th October 1952. Although the subsequent reappearance of a few larvae below the Ripon Falls raised a fear of rapid repopulation of the breeding sites, practical control, with an average fly count of less than one per day to eight bait-boys, was maintained for 3½ years. After the inundation of all breeding sites between the Ripon Falls and the newly constructed Owen Falls dam, a second series of applications was begun on 2nd May 1956. It consisted of ten weekly applications of 12·5 per cent. DDT in oil to give a concentration of 1 part DDT per 3 million parts water, made by gravity directly into the sluices of the dam and was highly successful, the fly count remaining at zero at least until 1st November 1956. Surveys carried out since 1946 have shown that *S. neavei* Roub. is by far the more important vector of *O. volvulus* [*cf.* **35** 109] in Uganda since very few rivers exist that provide conditions suitable for *S. damnosum*, and most of the country is mountainous, with *S. neavei* occurring wherever streams descend forested slopes and escarpments; onchocercosis is commonly encountered in human populations living within 10 miles of such slopes. The problems of the control of *S. neavei* [*cf.* **42** 60] are discussed; the use of DDT water-miscible oil concentrates adsorbed on vermiculite contained in calico bags anchored in streams showed considerable promise when these could be introduced at points of high turbulence giving a good stirring action, but proved disappointing in more sluggish streams. DDT in plaster blocks is useful, but the blocks do not withstand transport by local labour. These slow-emission techniques produce an initial concentration of less than 1 part DDT in 20 million parts water and a mean concentration of the order of 1 part in 100 million over a 48-hour period.

Aitken (T. H. G.). **Entomological aspects of the Trinidad virus research program,** pp. 573–580, 2 figs., 6 refs. A laboratory was established early in 1953 in Trinidad for the study of neotropical virus diseases of man and

animals, and its work is reviewed. Neutralisation tests indicated the presence in the island of at least six virus infections transmitted by arthropods, namely: dengue, yellow fever [*cf.* **45** 101; **46** 108], Ilhéus encephalitis [*cf.* **46** 159], St. Louis encephalitis [*cf.* **47** 158], Venezuelan equine encephalitis [*cf.* **33** 69] and eastern equine encephalitis, and the viruses of the first four were isolated on one or more occasions. Methods are described for collecting and processing arthropods for virus studies, and the results of investigations on the bionomics of various blood-sucking insects are summarised. Studies were carried out in the Rio Grande Forest on the vertical distribution of the 28 most prevalent species of diurnal blood-sucking Diptera, all of which were mosquitos except for two species of *Simulium* and one of *Culicoides*. Six of them were shown to have a preference for the forest canopy, and these included *Simulium samboni* Jennings, *Haemagogus spegazzinii spegazzinii* Brèthes and *Sabethes chloropterus* (Humb.), of which the percentages collected in the canopy were 98, 94 and 91, respectively. Except for *Culicoides diabolicus* Hffm. and *Simulium incrustatum* Lutz, which were found uniformly at all heights, the remainder were primarily inhabitants of the ground-level area, rarely straying into the upper strata.

Philip (C. B.), Hughes (L. E.) & Darrow (D. I.). **Experimental transmission of yellow fever virus by oriental mosquitoes,** pp. 587–592, 13 refs. The following is substantially the authors' abstract. The ability of oriental strains of *Aëdes aegypti* (L.) to transmit yellow fever is confirmed, colonies from Australia, Malaya and Formosa appearing equally capable of acting as vectors. The preponderance of evidence now supports the belief that there is no mosquito barrier to the introduction of yellow fever into the Far East [*cf.* **46** 153]. *A. pseudoscutellaris* (Theo.) and *A. polynesiensis* Marks [**46** 179–180] were shown for the first time to be able to transmit the virus experimentally, though they are not potentially dangerous, in view of their insular distribution in the South Pacific. A strain of yellow-fever virus from Trinidad proved more satisfactory for transmission than the Asibi strain from West Africa or the Costa Rican strain, the adaptability of the last having possibly been affected by 15 serial passages in mice. Although baby mice proved unsatisfactory as donors, they were readily and fatally infected by the bites of mosquitos and thus provide an acceptable substitute for monkeys in recipient tests.

Stage (H. H.). **Malaria-control problems in Vietnam,** pp. 615–622, 2 figs. The problems involved in the control of malaria in Vietnam, which arise mainly from difficulties of transport, national customs, lack of trained staff and the complexity of the Anopheline fauna, are discussed. There are 22 known species of *Anopheles* in the country. *A. minimus* Theo. and *A. jeyporiensis* James, both effective vectors [*cf.* **41** 94; **45** 197], form more than 80 per cent. of the catches in houses in the areas in which they occur, and *A. sundaicus* Rdnw., which breeds in brackish water and is also an effective vector [*cf.* **45** 71], is the most numerous mosquito in houses on parts of the coast; elsewhere, *A. vagus* Dön., an inefficient vector [*cf.* **29** 140, 151–152; **46** 201; **45** 70], is the most abundant. Six environmental zones are distinguished in regard to Anopheline breeding. *A. vagus* is present in all the three that lie below 60 ft. above sea-level, *A. sundaicus* in the lowest of them and *A. minimus* in the other two, but the endemic indices are low and the spleen indices do not rise above 20 per cent. In the two zones between 60 and 3,000 ft., where *A. minimus* and *A. hyrcanus sinensis* Wied. [*cf.* **45** 197] are the most abundant species, the spleen indices are 35–50 and over 50 per cent., respectively. Above 3,000 ft., although *A. jeyporiensis* is present, the spleen index varies from 0 to 3 per cent.

Fraga de Azevedo (J.), Gândara (A. F.) & Ferreira (A. P.). **Contribution to the knowledge of the *Anopheles* of Portuguese Timor as vectors of**

plasmodia, pp. 625–627, 2 maps. A survey carried out in Portuguese Timor between November 1955 and March 1956 resulted in the collection of nine species of *Anopheles*. Dissections were made of 100 females of *A. barbirostris barbirostris* Wulp, *A. sundaicus* Rdnw., *A. aconitus* Dön. and *A. subpictus subpictus* Grassi; oocysts occurred in four individuals of each of the first two and in one of the third, but no sporozoites were found in the salivary glands. The first two are thus the most important vectors of malaria in Timor. *A. vagus vagus* Dön., which was widespread, is thought not to be a vector of malaria there, and possibly not to feed on man.

Steyn (J. J.). **The South African vector of Rift Valley fever,** pp. 629–632, 12 refs. The following is based largely on the author's abstract. The virus of Rift Valley fever, a disease that affects mice, sheep, antelopes, cattle and man, has been isolated in South Africa, Kenya and Japan. In South Africa, *Aëdes* (*Ochlerotatus*) *caballus* (Theo.) is the sylvatic vector [**45** 120]. This mosquito overwinters in the egg stage. Not all the eggs respond simultaneously to flooding. Large numbers hatch at each flooding, but only one generation is produced if the water in a breeding place becomes permanent. Adults are normally encountered near their breeding sites, but are destroyed by heavy rain. They bite during the day and rarely enter houses. The virus was successfully transmitted in Kenya by inoculation of lambs with mosquitos of other species but not by their bite [**21** 163; **27** 88]. It was found occasionally by Smithburn, Haddow & Gillett in three wild mosquitos, *A. deboeri* subsp. *demeilloni* Edw., *A. tarsalis* (Newst.) and *Eretmapodites* sp. These workers also found that *E. chrysogaster* Grah. could transmit the virus by bite from mouse to lamb, from mouse to mouse and from lamb to mouse and that although the virus could survive for some days in *Mansonia fuscopennata* (Theo.) and *M. uniformis* (Theo.) [*cf.* **19** 208], these species transmitted it less well than *Eretmapodites* sp., whereas *A. aegypti* (L.) was not a vector. It was also found, in South Africa, that although both *A. caballus* and *Culex theileri* Theo. harboured the virus, only the first could transmit it by bite. Epidemiological findings in parts of South Africa, the rôle of irrigation schemes in the initiation of epidemics and the possible spread of the disease by land vehicles and aircraft, which are readily entered by *A. caballus*, are discussed.

Gregson (J. D.). **Recent cattle grub life-history studies at Kamloops, British Columbia, and Lethbridge, Alberta,** pp. 725–734, 5 figs., 6 refs. A girdling device [*cf.* **33** 177] developed in British Columbia for the collection of larvae of *Hypoderma* emerging naturally from cattle is described. In 1948–52, the larvae of *H. lineatum* (Vill.) began to emerge between 12th February and 10th March and the date by which half had emerged varied between 14th and 31st March. The daily peak of emergence occurred at about noon. The threshold temperature for pupation appeared to be 55°F. The adults appeared in mid-May, usually between 7.30 and 8.30 a.m. Of 511 released at varying distances from confined cattle, not one was captured on cattle more than 330 yd. from the release point and the greatest recapture (28 out of 191 released) was at 500 ft. Mating occurred within an hour of release. No males were recaptured. In subsequent studies in Alberta, a modified girdling device that left the back of the cattle open was used, and this allowed more accurate observations to be made on the length of time spent by the larvae in the backs of the cattle; this was shown to vary from 37 to 65 days for *H. lineatum* and from 44 to 81 days for *H. bovis* (Deg.) in 1951–52, during which years the percentage mortalities of the larvae of the two species were 59 and 51, respectively. A constant temperature of 20°C. [68°F.] was optimum for the development of the pupae; a relative humidity of 76 per cent. was the most favourable for *H. bovis*, but *H lineatum* showed no such effect. Unknown lethal factors were present in laboratory rearing.

Of larvae of *H. lineatum* that dropped in the field, 8–80 per cent. gave rise to adults, depending on the degree of shelter from the sun and the weather conditions experienced. The maximum time from the dropping of the larvae to the emergence of the adults was 65 days and the minimum 25 during a period in which the approximate minimum air temperatures rose from −29°C. [−20·2°F.] to −6°C. [21·2°F.]. There was a loss of water, and hence of weight, during the pupal stage, and this was found to occur chiefly during a period of reduced cold-hardiness at the beginning of it.

Rees (D. M.). **Report on the results of control methods applied to biting gnats in the vicinity of Salt Lake City, Utah (Diptera: Ceratopogonidae),** pp. 741–743, 3 refs. Work on the control of *Leptoconops kerteszi* var. *americanus* Carter was begun in a selected area near Salt Lake City, Utah, in the spring of 1948 and continued until the autumn of 1952, since when the area has been kept under observation. Studies of the life-history and habits of the Ceratopogonid showed that the eggs are deposited on suitably moist soil. The larvae, which were found about 6 in. below the surface in saturated soil, usually hatch in early March and migrate slowly towards the surface, where they pupate in early April. The adults emerge about 10 days later and are present for about six weeks during April, May and June, the time of emergence varying by as much as three weeks, according to the weather. Nearly 6,000 adults were collected in one season from a trap that covered an area of 3 sq. ft. Treatment of foot-square sample plots of soil, just before the larvae were ready to pupate, with a 2·5 per cent. solution of DDT was found to activate the larvae and to cause them to come to the surface, and this allowed rapid sampling in the field. The following is taken substantially from the author's summary of the work on control. It was found that water management, ploughing, filling and the application of chemicals can be effectively used to reduce the *Leptoconops* population. A reduction in the water content of the soil was the most effective. An emulsion spray affording 1 lb. DDT in 28 U.S. gal. water per acre as a direct larvicide, or 2 lb. per acre as a pre-hatch larvicide, gave good results, but the effectiveness of DDT at concentrations of up to 10 lb. per acre was apparently not retained after the second year. DDT and other insecticides in mists, sprays or aerosols proved effective against the adults for periods ranging from 4 hours to several days. Repellents were mostly unsatisfactory, but some of the more recently developed showed promise.

Snow (W. E.). **Production and control of floodwater mosquitoes incidental to water level operations on reservoirs of the Tennessee Valley Authority,** pp. 745–750, 3 figs. The following is virtually the author's abstract. As the marginal growth band has become more stabilised along the main river reservoirs of the Tennessee Valley Authority, as a result of the regularity of water level operations [*cf.* **33** 122], the floodwater mosquito, *Aëdes vexans* (Mg.), has become well established in the zone just above top summer pool level in certain reservoir areas. This zone is surcharged in spring as a malaria control operation, and this causes an initial brood of floodwater mosquitos to hatch. If the surcharge phase and recession to top pool level occur over a period of about 5 days, many larvae in grassy, well-drained situations become stranded in the vegetation. On the other hand, if water remains in the surcharge zone for several weeks, emergence of *A. vexans* generally occurs. The weekly cyclical fluctuation and seasonal recession phases of the malaria control programme are especially favourable for the control of floodwater mosquitos. Even when rains coincided with the upper end of the cycle and hatching in marginal grass occurred, scheduled recession over the next few days was sufficient to eliminate larvae by stranding. On many of the reservoirs in the tributary watershed, seasonal water-level recession is a regular operation whereby stored water is gradually released

during the drier periods in summer and autumn for downstream use. A recession rate of 0·2–0·3 ft. per week beginning shortly before 1st July has been found adequate for mosquito control. When stored water is allowed to remain in the marginal growth band for several weeks in the spring before recession is begun, small numbers of *A. vexans* usually emerge. In instances when the growth band has become periodically flooded during the summer with intermediate drawdown periods of several weeks intervening, very large populations of *A. vexans* have been produced.

Morales M. (E.). **Algunas observaciones sobre el control del tórsalo en Costa Rica** [Some observations on the control of *Dermatobia hominis* in Costa Rica], pp. 751–756, 3 figs., 2 refs. (With a summary in English.) The following is substantially the author's abstract. *Dermatobia hominis* (L. jr.) is one of the most important pests of cattle in Costa Rica. Little is known about its origin in the country. It occurs from sea-level up to nearly 4,000 ft., and prefers wooded, damp areas. One-third of all the cattle are either infested or in infested zones, and 30–35 per cent. of all the skins produced are damaged. In tests of sprays of 0·5–4 per cent. wettable chlordane against the larvae, the best interval between applications was found to be two weeks during the rainy season and three weeks during the dry season, and the lowest concentration was as good as the others; the cattle showed no ill effects. Emulsion and wettable-powder sprays of toxaphene, wettable-powder sprays of γ BHC (lindane), dips prepared from wettable powders of either of these insecticides and γ BHC used as a 3 per cent. smear gave promising results. To obtain effective control, pasture and grazing land must be kept free of weeds, especially tall ones, and insecticides of long residual effect should be used in the sheds to control the adults.

Tarshis (I. B.). **Feeding techniques for bloodsucking arthropods,** pp. 767–783, 6 figs., 55 refs. The following is based on the author's abstract. An apparatus and a technique are described [*cf.* **47** 148] for the *in vitro* feeding of fleas (*Xenopsylla cheopis* (Roths.)), mosquitos (*Aëdes aegypti* (L.)) and ticks (*Ornithodoros moubata* (Murr.)). The optimum conditions for feeding these arthropods through membranes were found to be a blood temperature of 34°C. [93·2°F.] with an ambient temperature of 19–30°C. [66·2–86°F.], the use of freshly drawn or thawed heparinised beef, rat or guineapig blood or whole human blood, a very thin, animal-derived membrane, and a feeding period of one hour. Of 29 membranes tested, 23 were new for *in vitro* feeding, and some of these proved highly satisfactory. The best membranes for feeding fleas, with (in brackets) the percentages that fed, were hamster skins (97), rat skins (95), Baudruche Transparent membrane (prepared commercially from bovine intestines) (94), Silverlight (a goldbeater skin obtained from ox caecum) (85) and rabbit skins (82). Silverlight was found best for mosquitos, and rabbit skins for ticks, the percentages feeding being 75 and 97.

Downes (J. A.). **The genus *Culicoides* (Diptera: Ceratopogonidae) in Canada; an introductory review,** pp. 801–807, 3 figs., 43 refs. The following is based on the author's abstract. More than 35 species of *Culicoides*, including several undescribed ones, have been found in Canada. These Ceratopogonids occur in damp places throughout the country and extend on to the tundra as far north as Victoria Island. A general account of the bionomics of the genus is given, and the salient features of the regional faunas are discussed. The sub-arctic and the prairie species tend to lose the blood-sucking habit, and these autogenous forms occur in great abundance where the soil provides a rich larval habitat. The blood-sucking species feed on man, other mammals and birds. *C. obsoletus* (Mg.) is widespread [*cf.* **47** 199], especially in Quebec and Ontario, as also is *C. yukonensis* Hffm., with others, in western Canada. *C. variipennis* (Coq.),

the vector of blue-tongue of sheep in the United States [*cf.* **42** 147], is abundant in Alberta and British Columbia.

Collins (D. L.) & Jamnback (H.). **Ten years of blackfly control in New York State,** pp. 813–818, 2 maps. The following is largely based on the authors' abstract. Simuliids have long been a hazard to health and an economic handicap in northern New York State. With the discovery of DDT and new methods of insecticide application, economically feasible control measures were developed. The use of fog generators against the adults was studied in 1945–46, and the first large-scale regional control programme was carried out in 1948 on 6,000 acres in the town of Webb; in this, Todd fog-heads were installed for the first time on a helicopter. The work was subsequently extended, until by 1956 some ten separate communities in northern New York, with an aggregate area of nearly 1,000 sq. miles, had been provided with control of some sort. Methods used included spraying against the larvae from aircraft, supplemented by the use of DDT-impregnated blocks of plaster of paris tied in position in rapid portions of streams, and control of adults by insecticide fogs and mists. The most important anthropophilous species in the region were found to be *Prosimulium hirtipes* (Fries), *Simulium venustum* Say and *S. tuberosum* (Lndst.). Control of the overwintering larvae of *P. hirtipes* requires the treatment of streams very early in spring, and since *S. venustum* is in the egg stage at that time, the treatment is repeated about three weeks later. DDT was the best larvicide and it can be applied from aircraft at dosages as low as 1 U.S. gal. 20 per cent. DDT solution per swathe-mile.

Fredeen (F. J. H.). **Black flies (Diptera: Simuliidae) of the agricultural areas of Manitoba, Saskatchewan, and Alberta,** pp. 819–823, 10 refs. The following is virtually the author's abstract. In 1947–55, Simuliids of 25 species were collected from an area in Manitoba, Saskatchewan and Alberta lying between 49 and 55°N. lat. Two additional species were previously reported. The immature stages are restricted to flowing water, and a complex of species was found in most of the 801 collections from the 283 streams and rivers examined. The females of many species require a blood-meal for the maturation of eggs. Productivity of animals and man is affected by attacks by *Simulium arcticum* Mall. [*cf.* **37** 122], *S. venustum* Say, *S. vittatum* Zett., *S. meridionale* Ril. and *S. luggeri* Nicholson & Mickel. A single outbreak of *S. arcticum* was responsible for more than 600 fatalities in domestic livestock. Swarms of *S. arcticum* have been carried more than 140 miles by the wind. The flight range of other blood-sucking species was found to vary from 10 miles (*S. venustum*) to 37 miles (*S. vittatum*). Some species overwinter in the egg stage, and others as larvae. Annual control of *S. arcticum* [*cf.* **42** 101] and *S. venustum* has been achieved in rivers with volume flows of up to 65,000 cu. ft. per second by eliminating larvae with single 15-minute applications of DDT at 0·1 part per million. A single application was effective as far as 115 miles downstream. Larvae were killed by ingesting silt particles with adsorbed DDT.

Lupascu (G.), Duport (M.), Cristescu (A.), Manoiu (C.) & Raicu (V.). **La présence de l'espèce *Phlebotomus perfiliewi* dans la République Populaire Roumaine—oecologie et phénologie,** pp. 829–834, 20 refs. The following is based on the authors' abstract. The species of *Phlebotomus* identified in Rumania up to 1955 were *P. papatasi* (Scop.) and *P. chinensis longiductus* Parr. In 1955, investigations in connection with the appearance during the preceding year of several cases of visceral leishmaniasis in the region of Craiova led to the finding of *P. perfiliewi* Parr. in that region, in three small farms on the outskirts of two of the six localities searched. Adults were taken in houses and outbuildings as well as in the open, but numbers were very small. Cases of visceral leishmaniasis had been recorded in two of the

houses concerned. The weather was unfavourable for the development of *Phlebotomus* in 1955, but numerous examples of *P. perfiliewi* were found in the burrows of *Citellus citellus* and in the ground nests of *Merops*. The abundance of this species in these natural habitats and its sporadic occurrence in proximity to man show that it is not a domestic species in Rumania [*cf.* **43** 107], although an increase in its numbers in the natural habitats in favourable years might cause a greater migration to human habitations.

Murnaghan (M. F.). **Tick paralysis in the dog: a neurophysiological study,** pp. 841–847, 4 figs., 18 refs. The following is based on the author's abstract. Tick paralysis was produced in mongrel dogs in 9 out of 23 trials in which approximately 10 females and 10 males of *Dermacentor andersoni* Stiles were applied to each animal. The symptoms observed in the affected animals are described. The sites of action of the tick " toxin " were found to be the neuromuscular junction and probably some synapses in the spinal cord [*cf.* **32** 80]. The evidence indicates that the mechanism of action is probably a decreased liberation of acetylcholine at these sites.

Craig jr. (G. B.) & Horsfall (W. R.). **Taxonomic and ecological significance of eggs of Aedine mosquitoes,** pp. 853–857, 21 figs., 7 refs. The following is largely based on the authors' abstract. Eggs of 42 of the 61 Nearctic species of *Aëdes* and 8 of the 13 Nearctic species of *Psorophora* were found to vary in size, outline, colour and chorionic detail according to genus, subgenus, group and even species in most instances. Whole eggs show sufficient specific details to permit rapid separation to species if examined in intense reflected light. Surface details of the chorion show patterns that are readily recognisable when examined as cleared material in a suitable transmitted light. The lateral aspects of the eggs of 9 species and details of the sculpture of the chorion of 12 species of *Aëdes* are illustrated; these include *A. aegypti* (L.), *A. communis* (Deg.), *A. dorsalis* (Mg.), *A. sollicitans* (Wlk.) and *A. vexans* (Mg.).

Levi-Castillo (R.). **Provisional list of the Culicidae, Simuliidae,** *Phlebotomus* **and** *Culicoides* **of Ecuador,** pp. 867–871. The author describes the climate of Ecuador and its bioclimatic regions and gives lists of the species of mosquitos, Simuliids, *Phlebotomus* and *Culicoides* found there up to 1st August 1956.

Rageau (J.). **Inventaire des arthropodes d'intérêt médical et vétérinaire dans les territoires français du Pacifique Sud,** pp. 873–882, 45 refs. The following is based on the author's abstract. A list is given of the arthropods of medical and veterinary importance in the French Pacific territories (the Marquesas, Society, Austral and Wallis Islands, Tuamotu, the New Hebrides, the Loyalty Islands and New Caledonia) comprising 162 species in 91 genera and 49 families, with brief indications of geographical distribution and pathological importance for man and domestic animals.

Hunter (P. E.), Cutkomp (L. K.) & Kolkaila (A. M.). **Reproduction in DDT- and diazinon-treated house flies.**—*J. econ. Ent.* **51** no. 5 pp. 579–582, 14 refs. Menasha, Wis., 1958.

In a study of the effect of sublethal doses of DDT and diazinon on all stages of reproduction in females of a DDT-resistant and a susceptible laboratory strain of house-flies (*Musca domestica* L.), the insecticides dissolved in olive oil were applied topically to adult females three days old at the dosage necessary to give about 50 per cent. mortality, and to the survivors at the same dosage on one or two successive days. Each surviving female was subsequently placed with an untreated male from the same culture in a cardboard container covered with wire gauze. A milk and sugar solution was provided as food, and larval medium was available for oviposition.

Treatment with DDT shortened the life span of the surviving females of the resistant strain by about 15 per cent., but diazinon had no similar effect. There was no significant difference between the life spans of females of the susceptible strain that were untreated or that survived the treatments, but their trend appeared similar to that in the resistant strain. Although treatment appeared to decrease the number of eggs per clutch (a clutch being defined as the eggs laid in 24 hours) in the resistant strain and to increase it in the susceptible one, the only significant difference was that between the females treated with diazinon and their controls. The only significant difference in mean number of clutches per laying female was a reduction shown by the DDT-treated females of the resistant strain as compared with diazinon-treated ones or the controls. The percentage of eggs hatching was significantly reduced in both strains by treatment with diazinon and in the resistant strain also by treatment with DDT, but in the susceptible strain, it was significantly greater in the DDT-treated flies than in diazinon-treated or control flies. In the resistant strain, the percentage of the progeny that survived to the adult stage was significantly lower for the DDT-treated females than for those of the other two groups, and there was no difference between these. In the susceptible strain, the percentage was significantly lower for the diazinon-treated group than for either of the others, and these did not differ significantly from each other. When all these factors and the proportion of females that failed to oviposit in each group were taken into account, the estimated number of potential adult progeny per 100 females from the resistant strain treated with DDT was about two-thirds of that from the untreated females, and the corresponding proportion for diazinon was about four-fifths. In the susceptible strain, the sublethal doses increased reproduction, diazinon doing so by 1 per cent., and DDT by about 18 per cent. The decreases in reproductive potentiality shown in the resistant strain and the increase in that of the susceptible strain following treatment with DDT can be attributed to a general reduction, or increase, in all stages of reproduction in the treated flies, and the small increase in that of the susceptible strain following treatment with diazinon almost exclusively to the greater number of eggs per clutch laid by the treated females. Some workers have found an increase in reproduction following exposure to dieldrin [*R.A.E.*, B **45** 112] and DDT [*cf.* A **43** 341] and others have found a decrease in certain aspects of reproduction in various species exposed to DDT [B **41** 105; **43** 50–51; **44** 77–78; A **45** 175–176].

Turner jr. (E. C.) & Gaines (J. A.). **Systemic insecticides for control of cattle grubs in Virginia.**—*J. econ. Ent.* **51** no. 5 pp. 582–585, 9 refs. Menasha, Wis., 1958.

Investigations were carried out in Virginia in 1957–58 to evaluate O-methyl O-(4-tert.-butyl-2-chlorophenyl) methylphosphoramidothioate (Dowco 109) and dimethoate administered orally in comparison with Dow ET-57 [purified O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate] and Dowco 109 applied as a spray in comparison with Bayer 21/199 [O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl phosphorothioate] for the control of larvae of *Hypoderma lineatum* (Vill.) and *H. bovis* (Deg.) in cattle. Preliminary experiments showed that *H. lineatum* began to appear in the backs in mid-January and *H. bovis* in early February. In one test, on cattle treated on 26th September with Dowco 109, ET-57 and dimethoate in boluses at 15, 110 and 8 mg. per kg. body weight, respectively, the numbers of larvae in the backs of the treated animals were in the course of the season significantly less than in those of the untreated ones, but did not differ significantly between themselves (0·9, 3, 6·1 and 12·2 larvae per animal, respectively);

in another test on 8th November, the numbers on cattle treated with Dowco 109 and dimethoate, both at 15 mg., were significantly different from those on the untreated ones and from each other (1·3, 9·8 and 32·4 per animal, respectively). In a test in which a fresh group of yearling heifers was treated orally each month from August to December inclusive with Dowco 109 at 15 mg. per kg. and counts were made in January, February and March, effectiveness did not appear to differ with time of application. The numbers of larvae in the backs varied from 0 to 2·6 in treated groups and was 13·3 in the untreated group. In spray treatments, 1 per cent. Dowco 109 and 0·75 per cent. Bayer 21/199 both gave excellent control, reducing the total numbers of larvae in the backs to 0·1–3·5 and 0·3–1·7 as compared with about 30 in the controls.

Studies on weight gains indicated that the benefits derived from *Hypoderma* control were greatly affected by the way the cattle were fed. The average gain in weight of steers that were on a winter subsistence diet was not increased by *Hypoderma* control, but that of heifers receiving a fattening ration was significantly greater in treated than in untreated animals. Inspection of the hides of the heifers at slaughter in late April or early June showed that the number of holes and fresh scars per hide was 0·7 in those that had received Dowco 109, 7·6 in those that received dimethoate and 25·3 in those that had not been treated.

Goulding (R. L.). **Sheep ked control in Oregon farm flocks.**—*J. econ. Ent.* **51** no. 5 pp. 585–587, 6 refs. Menasha, Wis., 1958.

Of recent years, most of the emphasis on the use of dusts against the sheep ked (*Melophagus ovinus* (L.)) has been on application by power to relatively large groups of sheep [*cf. R.A.E.*, B **34** 163; **46** 82]. However, considerable numbers of sheep are reared in western Oregon in small flocks on which power dusting would be impracticable. A high level of control was effected on these by an application of 1·5 per cent. dieldrin dust with a hand operated rotary duster. Application to the sheep, which were of the medium-wool type characteristic of western Oregon, was at about 2 oz. dust per head. Infestations were assessed by examination of ten vertical samples 8 in. long on each side of a representative sample of ewes and lambs. The average number of adults and pupae per lamb at shearing time in 1957 in treated flocks that had had no contact with untreated animals was 0–1 and the percentage of lambs infested 0–30. In the three untreated control flocks, all lambs were infested and there were 11·6–16·5 keds and pupae. Post-treatment re-infestation due to mingling of treated and untreated flocks was found to reduce materially the effectiveness of the treatment, but the effect on the degree of control of either three or six untreated sheep in a flock was less apparent. Little difference could be detected whether the application had been made in April-June just after the ewes were shorn, in September at the end of the summer pasture cycle or before lambing in December. Under conditions in western Oregon, treatments after the last fat lamb has been selected from the flock in the autumn and before the flock or the remaining lambs go on winter feed are thought most likely to result in minimum dieldrin residues in lambs at slaughter [*cf.* **44** 55].

Sömme (L.). **The number of stable flies in Norwegian barns, and their resistance to DDT.**—*J. econ. Ent.* **51** no. 5 pp. 599–601, 12 refs. Menasha, Wis., 1958.

Of 5,954 flies observed in representative resting places in barns on 11 farms in eastern Norway during the summers of 1956, 1957 or both, 74·5 per cent.

were stable flies (*Stomoxys calcitrans* (L.)), 15·3 per cent. were house-flies (*Musca domestica* L.) and 10·2 per cent. belonged to the genus *Fannia*. In view of the high proportion of *S. calcitrans* and of reports that chlorinated insecticides, which had been used in Norway for some years, were failing to kill flies, the susceptibility of four field-collected strains of *S. calcitrans* was tested by exposure in cylinders of treated blotting paper. The LT50's (exposure times in minutes needed to kill or knock down 50 per cent.) for females and (in brackets) males from farms 1, 2, 8 and 9 were 312 (78), 240 (63), 72 (60) and 48 (41) for DDT and 225 (165), 48 (42), 49 (42) and 45 (42) for γ BHC (lindane). No insecticides had been used for at least two years on farms 8 and 9, both DDT and γ BHC had been used during the last two summers on farm 1, and no information was available for farm 2. These differences in tolerance were not considered great enough to indicate any appreciable amount of resistance. When the strain from farm 1 was subjected to selection by breeding from survivors of exposure to DDT at the 60 per cent. mortality level, the LT50's for males and females increased from 78 to 918 and from 312 to 1,440, respectively, in two generations, while, at the same time, the LT50 for females of an unselected strain from the same farm decreased to 78 and that for males remained steady. Because of difficulties in rearing, some of the data were based on small numbers of flies, but they strongly suggest that *S. calcitrans* can become resistant to DDT.

Hull jr. (G.) & Davidson (R. H.). **The biology of the brown-banded cockroach and its relative susceptibility to five organic insecticides.**— *J. econ. Ent.* **51** no. 5 pp. 608–610, 16 refs. Menasha, Wis., 1958.

Supella supellectilium (Serv.) has become of widespread importance as a household pest in the United States, where it has spread throughout the south and to much of the north and west. Laboratory studies on its bionomics were made at a fairly constant temperature of about 82°F. and a relative humidity of 35–55 per cent. (average 43 per cent.). It was found that the average pre-oviposition period for 19 adult females was 17·7 days. Each produced an average of ten egg capsules, and the periods between deposition averaged 9·8 days. As many as 29 capsules were deposited by a single female, and about one-third of those from each female hatched [*cf. R.A.E.*, B **29** 56]. The incubation period of 14 capsules obtained from seven different females averaged 58·4 days. The maximum number of nymphs to hatch per capsule was 18, with an average of 12·8 for all capsules considered. The average length of adult life of 20 females was 115 days. The number and duration of instars were determined by spraying the nymphs with aluminium paint after each moult. Out of 50 nymphs, 37 completed development. They had a total of 7–9 instars, the most usual number being seven. Differences in food utilisation and fluctuations in relative humidity may have been responsible for the variation in the number of moults and duration of instars of nymphs from the same female that was observed in these studies. The total period of nymphal development averaged 89·7 days for the 37 nymphs.

To test the relative susceptibility of *S. supellectilium* to aldrin, chlordane, DDT, heptachlor and γ BHC (lindane), the insecticides were applied topically in emulsions between the prothoracic coxae to females that had just completed the final moult. Various dosages were tried until at least three had been found that gave more than 0 and less than 100 per cent. mortality, and relative toxicities were determined from these data. The LD50 and LD90 values showed γ BHC to be the most effective compound, followed in order of decreasing toxicity by heptachlor, aldrin, chlordane and DDT. This order of toxicity was similar to that found for *Blattella*

germanica (L.) [**44** 172], but the differences between the insecticides were much smaller in the present work. The susceptibility of *S. supellectilium* was found not to differ greatly from that of a normal strain of *B. germanica* as determined in a paper already noticed [**42** 136], and it is concluded that the difficulty reported in controlling the former must be attributable to failure to take into consideration the habits of *S. supellectilium*, which occurs throughout the house with a preference for shelves, picture rails, etc. [*cf.* **35** 91], or possibly to the existence of resistant strains.

Ogden (L. J.) & Kilpatrick (J. W.). **Control of *Fannia canicularis* (L.) in Utah dairy barns.**—*J. econ. Ent.* **51** no. 5 pp. 611–612, 1 graph, 7 refs. Menasha, Wis., 1958.

In 1957, studies were made in northern Utah to evaluate the effectiveness of cords impregnated by immersion for five minutes in a solution of 10 per cent. parathion and 2·5 per cent. diazinon in xylene and dry poison baits containing 2 per cent. malathion and 0·25 per cent. dichlorvos (DDVP) for the control of *Fannia canicularis* (L.). Cords were installed between 24th and 29th June in milking rooms, calf pens and loafing sheds on six dairy farms at rates of about 30 ft. of cord (3/32 in. diameter) per 100 sq. ft. of floor area [*cf. R.A.E.*, B **46** 43]. Satisfactory control of *F. canicularis* was obtained in five of the six farms throughout the 12-week observation period, numbers never exceeding 36 per 500 sq. ft., whereas they had been 400–1,500, and they remained high on untreated farms for at least six weeks. Control was considered satisfactory (50 flies or less per 500 sq. ft.) at the sixth farm in 9 of the 12 weeks. The bait exposed on the floor, window sills, etc., in plywood trays covered with hardware cloth at a dosage of 4 oz. bait per 1,000 sq. ft. of floor area and renewed weekly failed to reduce numbers of *F. canicularis* significantly on the two farms on which it was tried, as the flies were not attracted to it.

LaBrecque (G. C.), Wilson (H. G.) & Gahan (J. B.). **Resistance of house flies in Florida to organophosphorus insecticides.**—*J. econ. Ent.* **51** no. 5 pp. 616–617, 4 refs. Menasha, Wis., 1958.

House-flies (*Musca domestica* L.) were collected in eight dairy barns and four poultry houses in central and southern Florida in 1957. Tests with contact sprays in a wind tunnel [*cf. R.A.E.*, B **47** 85] were carried out on the parental generations (collected as larvae) or on the F_1 generations, or on both, and on the F_5 generations of the Tampa and Grothe strains [*loc. cit.*]. These showed the 14 strains to be 3·2–133·3 times as resistant as normal flies to malathion; 10 of them were 1·3–72 times as resistant as normal flies to trichlorphon (Dipterex), four were 5–38·8 times as resistant to diazinon and six were 3·5–>18 times as resistant to parathion. Resistance to malathion was high (more than 15-fold) in all strains except four from dairy barns in central Florida. Resistance to trichlorphon was high in six strains, including one from central Florida, and one strain showed high resistance to diazinon and parathion. Concurrent tests with dry poisoned sugar baits showed six of the strains from southern and four of the strains from central Florida to be, respectively, 47–>105 and 13–51 times as resistant to malathion, and the four strains from central Florida to be 3–19 times as resistant to trichlorphon, as normal flies. Resistance to trichlorphon or malathion baits in 1956 and to trichlorphon in 1954 had not exceeded eight times the normal in flies from the barns in central Florida from which these four strains were collected. The resistance shown to the compounds in baits in 1957 was generally higher than that shown to the same compound in contact sprays.

Cheng (Tien-hsi), Patterson (R. E.), Avery (B. W.) & Vanderberg (J. P.). **An electric-eye-controlled sprayer for application of insecticides to livestock.**—*Bull. Pa agric. Exp. Sta.* no. 626, 14 pp., 10 figs., 3 refs. University Park, Pa., 1957.

Cheng (Tien-hsi), Frear (D. E. H.) & Enos jr. (H. F.). **The use of treatments containing methoxychlor against biting flies on cattle and the determination of methoxychlor residues in milk.**—*J. econ. Ent.* **51** no. 5 pp. 618–623, 4 figs., 5 refs. Menasha, Wis., 1958.

As treadle sprayers used for the control of biting flies [*R.A.E.*, B **39** 153] often give incomplete coverage and many cattle are nervous of them, and as back rubbers of the cable type are ineffective against *Stomoxys calcitrans* (L.) [**47** 101] and Tabanids and have to be re-impregnated after heavy rain, the photoelectrically controlled sprayer described in the first paper was designed to eliminate these defects, while retaining the good features of the treadle sprayer. Its main components included a rectangular system of pipes with ten nozzles, a photoelectric relay unit, a pump and motor assembly and a solenoid valve. There was also a by-pass system for the spray when the nozzles were not in action. It was installed in the doorway of a cattle shed to treat dairy cows and in a frame built into a feeding shelter in a pasture to treat beef cattle. In both cases, it was completely concealed from the animals, and they needed little training to use it. As an animal passed through the doorway or frame, it interrupted the passage of a beam of light to the photoelectric unit, which caused the solenoid valve to close, so that the by-pass line was blocked and the spray was confined to the pipe system. This so raised the pressure that the liquid was forced through the nozzles, which together delivered about 70 ml. spray per second at a pressure of 80 lb. per sq. inch. Actual spraying time per animal varied from 1 to 2 seconds, and coverage was complete, adequate and uniform. When the animal left the doorway, the beam was restored and the solenoid valve opened again and released the pressure through the by-pass, so that spraying ceased instantly.

During the summer of 1956, tests were carried out in central Pennsylvania to study the operation of the sprayer and the effectiveness of various insecticide-repellent formulations applied by it in controlling biting flies (including *Siphona irritans* (L.), *Stomoxys calcitrans*, *Tabanus sulcifrons* Macq. and *T. giganteus* Deg.). An oil-base spray containing 6 per cent. butoxy polypropylene glycol in combination with 0·035 per cent. pyrethrins and a synergist gave 98·8–99·9 per cent. reduction in *Siphona*, 81·6–94·7 per cent. reduction in *Stomoxys* and 84·2–97·4 per cent. reduction in the Tabanids on the cattle for 23·5 hours after treatment, whereas a water-base spray of 10 per cent. butoxy polypropylene glycol and 1 per cent. methoxy-DDT (methoxychlor) gave 85·6–96·5 per cent. reduction in *Siphona* but only 43·2–74·6 per cent. reduction in *Stomoxys* over an observation period of 31 hours. The addition of 3 per cent. Thanite to the latter resulted in complete control of *Siphona* and 89·2–95·6 per cent. reduction in *Stomoxys*. A water-base spray of methoxy-DDT alone at 2·5 per cent. gave 89·2–97·4 per cent. reduction in *Siphona* for 10·5 hours, but only 34·6–50 per cent. reduction in *Stomoxys*. None of the cattle showed any adverse effects after three months of testing.

Continued experiments in 1957 with formulations containing methoxy-DDT and determination of residues of this compound in the milk of treated cows are the subjects of the second paper. The use of methoxy-DDT on lactating cows was permitted in the United States when the work was planned, but the amount of the compound that would be tolerated in milk had been fixed at 0 before it had been completed. Treatments were applied once a day,

usually daily but sometimes less often, to two herds of lactating dairy cattle by means of the photoelectrically controlled sprayer, and a third had access to a cable-type back rubber [**47** 101, etc.]. Populations of *Siphona*, *Stomoxys*, *T. sulcifrons* and *T. giganteus* on treated and control groups were counted once or twice a day to determine the effectiveness of the treatments. On one farm, three formulations were applied successively with the sprayer at 120 ml. per animal per application over a total period of 68 days. A spray containing 1 per cent. methoxy-DDT in combination with 0·6 per cent. Lethane 384 [β-butoxy-β'-thiocyanodiethyl ether], 0·25 per cent. piperonyl butoxide, 0·03 per cent. pyrethrins and 8·6 per cent. butoxy polypropylene glycol in oil gave 91·8–94·9 per cent. reduction in *Siphona* and *Stomoxys* and was significantly more effective than a spray consisting of 1 per cent. methoxy-DDT and 15 per cent. N,N-diethyl-m-toluamide in a water emulsion, which gave 83·4–86·9 per cent. reduction. The addition of 3 per cent. Thanite to the water-base spray tended to increase its effectiveness appreciably (86·8–96·1 per cent. reduction). Tabanids were scarce and were disregarded. On the other farm, observations were made over a total period of 66 days. A water-base spray containing 1 per cent. methoxy-DDT and 3 per cent. Thanite applied at 75 ml. per animal gave only 49–63·3 per cent. reduction in *Stomoxys* and Tabanids, but effectiveness was markedly increased (70·2–97·4 per cent. reduction) by the addition of 10 per cent. butoxy polypropylene glycol. *Siphona* was not plentiful enough for inclusion in the results. Observations on the effectiveness of treatments applied by means of the back rubber were made at the first farm and continued for 73 days. A mixture containing 1 per cent. methoxy-DDT, 10 per cent. butoxy polypropylene glycol and 3 per cent. Thanite in oil, used for 40 days, gave only 41·7–82·8 per cent. reduction in *Siphona* and *Stomoxys*, but the effectiveness of the mixture was significantly enhanced when the concentration of methoxy-DDT was increased to 4 per cent., and a reduction of 73·9–94·9 per cent. was achieved for the next 33 days. The rubber was resoaked with the formulation after every heavy fall of rain. All the treatments were, in general, much more effective against *Siphona* than against *Stomoxys* or *Tabanus* when the data were examined separately. The cattle were not adversely affected by treatment.

Milk samples collected from cows receiving the oil-base spray containing 1 per cent. methoxy-DDT showed a maximum residue of 0·1 part per million with a mean of 0·04 p.p.m. for a period of 29 days. The water-base sprays, applied to the two herds over periods of 33 and 66 days, respectively, showed a maximum of 0·09 p.p.m. methoxy-DDT in the milk, with a mean of 0·04 p.p.m. Cows having access for 40 days to back rubbers treated with a formulation containing 1 per cent. methoxy-DDT did not excrete measurable amounts (more than 0·01 p.p.m.) of the compound in their milk; the same cows exposed later for 33 days to a back rubber treated with 4 per cent. methoxy-DDT showed a maximum of 0·03 p.p.m. and a mean of 0·01 p.p.m. in their milk. The presence of pyrethrins, piperonyl butoxide, butoxy polypropylene glycol, organic thiocyanates and diethyltoluamide did not appear to affect the excretion of methoxy-DDT by the treated cows.

Ihndris (R. W.) & Sullivan (W. N.). **Laboratory fumigation tests of organic compounds.**—*J. econ. Ent.* **51** no. 5 pp. 638–639, 1 fig., 4 refs. Menasha, Wis., 1958.

In view of the danger of the dissemination of harmful Diptera by aircraft, 78 organic compounds known to have insecticidal properties were tested as potential aircraft fumigants in laboratory tests against house-flies (*Musca domestica* L.). The flies in exposure jars were separated by wire gauze from

an air-circulating device and a filter paper impregnated with an acetone solution of the compound to give a concentration of 50 parts per million with complete vaporisation. Under these conditions, five halogenated phosphorus compounds, dichlorvos (DDVP), diethyl 2,2-dichlorovinyl phosphate, dimethyl 2-chlorovinyl phosphate, dimethyl 1,2,2,2-tetrachloroethyl phosphate and Dow ET-57 (purified O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate) and three halogenated hydrocarbons, aldrin, heptachlor and γ BHC (lindane) caused complete knockdown in less than two hours and complete kill in 24 hours. Dichlorvos had the quickest action, giving complete knockdown in 25 minutes, but it has relatively high toxicity to mammals, with an oral LD50 for rats of 56–80 mg. per kg. ET-57 required 111 minutes for complete knockdown but shows considerable promise because of its low toxicity to mammals (oral LD50 of 1·5–2 g. per kg. for rats), its freedom from odour and its high vapour pressure.

Schmidt (C. H.) & Weidhaas (D. E.). **Absorption and toxicity of three radioactive insecticides in larvae of two species of mosquitoes.**—*J. econ. Ent.* **51** no. 5 pp. 640–644, 3 figs., 5 refs. Menasha, Wis., 1958.

The uptake by mosquito larvae and toxicity to them of DDT, Bayer 21/199 [O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl phosphorothioate] and dimethoate (Am. Cyanamid 12880) were studied in Florida by radioactive-tracer techniques. The experiments were carried out on fourth-instar larvae of *Anopheles quadrimaculatus* Say and *Aëdes taeniorhynchus* (Wied.), using p,p′DDT synthesised with radioactive carbon (^{14}C), and Bayer 21/199 and dimethoate synthesised with radioactive phosphorus (^{32}P). With exposures of 24 hours, the LC50's of Bayer 21/199 and dimethoate in water were about five and 430 times, respectively, that of DDT for *Anopheles* and three and 1,000 times that of DDT for *Aëdes*. The larvae of *Anopheles* were more susceptible than those of *Aëdes* to DDT and dimethoate, but less so to Bayer 21/199. The slopes of the various dosage-mortality regression lines were similar. When the absorbed dosage, as indicated by radioactivity, was considered, however, differences were very small, the order was not the same, many of the dosage-mortality regression lines crossed, and the LD50's of dimethoate and DDT were, respectively, 1·2 and 1·8 times that of Bayer 21/199 for *Anopheles* and 2·4 and 3·8 times for *Aëdes*. The *Anopheles* larvae showed lower absorbed dosages of all three insecticides than did *Aëdes*, except at the higher mortality levels with Bayer 21/199. Increasing the number of larvae of *Anopheles* per unit volume resulted in lower mortalities and lower absorbed dosages with DDT, but no change with Bayer 21/199 or dimethoate. The percentages of the total available DDT removed were about 6–12 and 37–60 times as great as those of Bayer 21/199 and dimethoate, respectively. Larvae of *A. quadrimaculatus* exposed to 0·03 part Bayer 21/199 per million for 48 hours took up most of the absorbed dosage in the first few hours, but the mortality increased with time. When the larvae were exposed to Bayer 21/199 at 0·04 p.p.m. for six hours and then transferred to clean water, 73 per cent. of the acquired dosage was excreted in 12 hours. In a six-hour exposure, living larvae of *Anopheles* and *Aëdes* absorbed eight and four times as much Bayer 21/199, respectively, as did dead larvae of the same species.

Blum (M. S.) & Pratt jr. (J. J.). **Relationships between structure and synergistic activity of some structural analogs of DDT.**—*J. econ. Ent.* **51** no. 5 pp. 647–650, 15 refs. Menasha, Wis., 1958.

The synergistic activity with DDT of 28 compounds structurally related to it was tested by topical application of the test compound and DDT in

acetone, at dosages of 1 and 5 μg., respectively, to house-flies (*Musca domestica* L.) of a resistant strain. Earlier work had shown that the presence of p-chloro-substituents is correlated with optimum synergistic activity [*R.A.E.*, B **41** 74], and it was subsequently indicated that the activity of DDT synergists with different para-substituents varies with the alkyl moiety associated with the substituted aryl groups [*cf.* **43** 27; **45** 1]. The 28 compounds tested belonged to seven groups, and attention was directed chiefly to the effect of varying the para-substituent.

The following is based largely on the authors' summary of the results. In the p,p′-substituted diphenylmethane series, synergistic activity was destroyed when bromine, fluorine, methyl or nitro was substituted for chlorine atoms. The p,p′-fluoro-substituted diphenylethane was inactive. The 1,1-di(p-chlorophenyl)- and 1,1-di(p-bromophenyl)ethyl chlorides were more active than the corresponding p-methyl derivative, but less active than 1,1-di(p-chlorophenyl)ethane, which was the only compound giving complete mortality after 24 hours in combination with DDT at the dosages used. The diphenylethylenes showed this same pattern of activity, 1,1-di(p-chlorophenyl)ethylene, which with DDT gave 86 per cent. mortality, being more active than the corresponding methyl compound. The p,p′-chloro-, bromo- and methyl-substituted diphenylvinyl chlorides were less active than their corresponding ethylenes or ethyl chlorides. The vinylidene chlorides and bromides exhibited no synergistic activity, whatever the nature of the para-substituents. DDT alone at 5 μg. gave 7 per cent. mortality in 24 hours, and the test compounds alone at 10 μg. were less toxic than this.

Patton (R. L.) & Sarkaria (D. S.). **The gross pathology of the American cockroach following injection with organic solvents.**—*J. econ. Ent.* **51** no. 5 pp. 663–665, 2 refs. Menasha, Wis., 1958.

The following is based on the authors' abstract and conclusions. Sublethal doses of organic solvents of various chemical categories were injected into the body cavities of young adults and nymphs of *Periplaneta americana* (L.), and a comparative study was made of the gross pathological changes of the tissues and organs that resulted. There was a striking similarity between the effects noted and those brought about by similar compounds in mammals. Compounds that cause kidney lesions in mammals damaged the malpighian tubes in the cockroaches, and those that cause liver degeneration led to fatty degeneration of the fat-body. In most cases, toxicity increased with the number of carbon atoms in the molecule. The results obtained show the importance of a careful study of the toxicity of solvents used as carriers for insecticides in studies of mode of action; they also indicate the possibility of selecting adjuvants that will enhance the activity of an insecticide by selective blocking of the organ in the insect that is responsible for detoxication.

Cole (M. M.) & Clark (P. H.). **An attempt to reduce DDT resistance in body lice by reverse selection.**—*J. econ. Ent.* **51** no. 5 p. 665, 2 refs. Menasha, Wis., 1958.

An attempt was made, by selecting the most susceptible individuals in each generation and breeding from them, to increase or accelerate the loss of DDT resistance in a Korean strain of *Pediculus humanus humanus* L. that was practically immune from DDT poisoning and from which a colony had previously been isolated that had failed to lose all resistance to DDT in

45 generations [*R.A.E.*, B **46** 168]. It was advisable to use DDT or a related chlorinated hydrocarbon for selection, and 1-(p-chlorophenoxy)-2,3-epoxypropane was chosen because it gave rapid knockdown with high recovery. Two colonies of lice were set up. In one, the third-instar nymphs were exposed to cloth treated with a concentration of the chemical that gave about 50 per cent. knockdown in one hour, and those that were knocked down were subsequently allowed to recover on untreated cloth and used for breeding. In the other, the lice were maintained on untreated cloth. Some adults of each generation were exposed on cloth treated with 10 per cent. DDT in acetone in beaker tests [**34** 44], and no loss of resistance was apparent in 20 generations in either colony.

Siverly (R. E.). **Effects of chilling of pupae on subsequent emergence of resistant and susceptible house flies.**—*J. econ. Ent.* **51** no. 5 pp. 666–668, 2 graphs, 7 refs. Menasha, Wis., 1958.

To measure possible differences in the responses of *Musca domestica* L. of susceptible and insecticide-resistant strains to chilling, 2,400 pupae of each of two strains, one resistant and the other susceptible to DDT, were exposed to a temperature of 40°F. for periods of 1–8 days. While not being chilled, they were kept with the control pupae (300 from each strain) at a constant temperature of 80°F. The numbers, sex ratios and delays in emergence of adults from pupae chilled for various periods were compared. The numbers emerging were reduced by about 9 per cent. in the susceptible strain and by about 7 per cent. in the resistant strain for each day of chilling. Considerably more adults of the susceptible than of the resistant strain emerged in both treated and untreated samples, but after chilling for eight days the numbers of adults of both strains that emerged were approximately the same. Deviations from the expected equality of the sexes were not significant in either the control or the chilled samples of the susceptible strain, but significantly more males than females emerged in the chilled samples of the resistant strain. However, the sex ratio did not vary with duration of exposure to chilling, and it is thought that limiting factors, probably in the larval diet, prevented flies of the resistant strain from completing some phase of their development, that these factors were selective against females and that had the control sample of the resistant strain been larger, the number of males emerging in it would have been significantly greater than the number of the females, as they were in the treated samples. The delay in adult emergence was greater the longer the exposure of the pupae to chilling, and there was no significant difference between the strains in this respect.

Gersdorff (W. A.) & Piquett (P. G.). **Relative toxicity and intensity of synergism of mixtures of piperonyl butoxide with the *cis* isomers of allethrin as house fly sprays.**—*J. econ. Ent.* **51** no. 5 pp. 675–678, 6 refs. Menasha, Wis., 1958.

The results of a study of the insecticidal action of mixtures of piperonyl butoxide with each of the *trans* stereoisomers of allethrin were given by the authors in an earlier paper [*R.A.E.*, B **46** 79]. In the present one, they report on similar tests with 10:1 mixtures of piperonyl butoxide with the *l*-allethrolone *d-cis* chrysanthemic acid ester, the *d-l*, *l-l* and *d-d* esters, *dl-cis* fraction and allethrin itself, applied as space sprays in refined kerosene against house-flies (*Musca domestica* L.). The allethrin was 93·4 per cent. pure. The six mixtures were, respectively, 0·842, 0·341, 0·074, 3·86, 1·55 and

3·12 times as toxic on the basis of the median lethal concentrations of their insecticide (ester) equivalents [*cf.* **41** 101] as allethrin alone. Synergism with respect to mortality was demonstrated in all mixtures. Its intensity ratio was about 2·63 at the 50 per cent. mortality level for those containing the *l-d* and *d-l* esters and *cis*-allethrin, 2·17 for that containing the *d-d* ester, and 3·69 for that containing the *l-l* ester. As in the case of the *trans* isomers, the ratio for the *l-l* ester was deduced and could not be demonstrated directly, probably because of the relatively low toxicity of the isomer. It thus appears that the change in relative positions of certain atomic groups in the *cis* and *trans* arrangements causes a decrease with the *d-d* form and an increase with the *l-l* form in intensity of synergism as well as in relative toxicity. The intensity ratios were one-fourth less at the five per cent. and about one-third more at the 95 per cent. mortality level than at the 50 per cent. level. The mixtures of ester and synergist retained high knockdown value. The narrow range shown by the knockdown data for each mixture prevented them from being analysed in the manner used for the *trans*-isomer mixtures. Stability tests with the *l-d* and *d-d* esters showed that neither had lost any toxicity during storage in 2 per cent. kerosene solution for 20 months.

O'Brien (R. D.), Thorn (G. D.) & Fisher (R. W.). **New organophosphate insecticides developed on rational principles.**—*J. econ. Ent.* **51** no. 5 pp. 714–718, 1 graph, 18 refs. Menasha, Wis., 1958.

The low toxicity of malathion to mammals is probably due to the vigorous hydrolytic degradation of the compound or of its metabolite, malaoxon, in the liver [*cf. R.A.E.*, B **46** 80]. This is believed to occur at the carboxylic-ester bond, and it was thought that the introduction of such a bond into an organophosphorus anticholinesterase would confer selective toxicity towards insects as compared with mammals, that this effect would be strongest when the carboxyester group was close to the phosphorus in the molecule, and that it would be particularly marked in phosphorothionates, in which the lag in poisoning, due to the need for oxidation of the thiono group, would give time for the detoxifying hydrolysis to occur.

Several esters of phosphorothioic acids were prepared and tested for toxicity to *Musca domestica* L., by topical application in acetone, and to *Periplaneta americana* (L.) and mice, by injection; for anticholinesterase activity; and for metabolism by mouse liver and preparations of the insects. Comparisons of the LD50's for the mice and house-flies showed that the phosphorothionates containing a carboxyester group, which comprised O,O-diethyl S-ethoxycarbonylmethyl phosphorodithioate (acethion), O,O-diethyl S-ethoxycarbonylethyl phosphorodithioate (prothion), O,O-diethyl S-1-(2-methoxycarbonyl)propyl phosphorodithioate (methyl methprothion) and malathion, were selectively toxic to the insect, whereas those lacking the carboxyester group, O,O-diethyl S-methoxycarbonyl phosphorodithioate (acethion acid) and O,O-diethyl S-acetonyl phosphorodithioate (ketothion) were not selective; the fact that O,O-diethyl S-carbamidomethyl phosphorodithioate (acethion amide) was selective suggested that amidases are more vigorous in the mouse than in the house-fly. The phosphorothiolates containing the carboxyester group, O,O-diethyl S-ethoxycarbonylmethyl phosphorothioate (acetoxon) and O,O-diethyl S-ethoxycarbonylethyl phosphorothioate (propoxon), were less selective than the corresponding phosphorothionates, acethion and prothion, and showed higher activity against serum cholinesterase, prepared from human plasma, than the other compounds; very similar values were obtained with other cholinesterases.

When acethion was incubated with a homogenate of mouse liver, assay

of the extracted products by chromatography showed that it was almost completely degraded to form acethion acid. As microsomes from the liver have been shown to activate phosphorothionates [*cf. loc. cit.*], mouse microsomes (with reduced diphosphopyridine nucleotide, magnesium chloride and nicotinamide) were incubated with some of the compounds in the presence of serum cholinesterase, and comparison of their anticholinesterase activity with that of the unmetabolised compounds showed that activation occurred in malathion and acethion amide, but degradation in acethion, acethion acid, acetoxon, prothion, methyl methprothion and ketothion. Chromatographic analysis after degradation by microsomes showed that only acethion acid was produced from acethion and that the acid gave no detectable new products. Assay against serum cholinesterase confirmed that minced mouse liver degraded acethion rapidly and almost completely and showed that minced cockroach degraded it considerably, whereas minced house-fly caused slight activation; this was in accordance with the LD50's of 1,280, more than 1,000 and 9·4 μg. per g. for mice, cockroaches and house-flies, respectively.

McGregor (W. S.), Wade (L. L.) & Colby (R. W.). **Systemic control of *Dermatobia hominis* (L., jr.) in Central and South American cattle with Narlene insecticide.**—*J. econ. Ent.* **51** no. 5 pp. 724–725, 2 refs. Menasha, Wis., 1958.

Tests in which O-methyl O-(4-tert.-butyl-2-chlorophenyl) methylphosphoramidothioate (Narlene) was used as a systemic insecticide to treat range cattle [*cf. R.A.E.*, B **48** 16] in Panama, Costa Rica, Colombia and Brazil showed that a single oral dose of 20 mg. per kg. body weight or a 0·5 or 0·75 per cent. spray at 2 litres per animal gave almost complete control of a general infestation of *Dermatobia hominis* (L. jr.) for eight weeks. Occasional large, mature larvae survived, presumably because they had ceased to feed. There appeared to be no difference in the effectiveness of an oral drench or bolus. Oral doses of 10 mg. per kg. killed nearly all encysted larvae, but a 5 mg. drench and a 0·25 per cent. spray were not effective. Wettable powders and emulsifiable concentrates were equally effective in sprays, complete coverage was not necessary, and heavy rain after the spray had dried had no adverse effect. The sprays also gave good control of *Siphona irritans* (L.), lice and mosquitos, which perhaps accounted in part for the long protective period before reinfestation with *Dermatobia* occurred. Dairy calves tolerated oral doses of 50 mg. per kg., and 0·75 per cent. sprays were safe for use on young animals. Milk of cows receiving a 0·75 per cent. spray contained a residue of 0·4 part Narlene per million after 24 hours, 0·2 p.p.m. after 48 hours and none after ten days; carcass fat contained 0·5 p.p.m. at ten days and less than 0·1 p.p.m. at 21 days after spraying. After a single oral dose of 25 mg. per kg., 32 days were required for the residue in the fat to fall below 0·1 p.p.m., but residues in the lean-meat tissues were eliminated more rapidly.

DeWitt (J. B.). **The function of the Fish and Wildlife Service in insect control programs.**—*J. econ. Ent.* **51** no. 5 pp. 740–741. Menasha, Wis., 1958.

In continuation of studies in the United States on the effects on wild animals and birds of insecticides applied against harmful insects [*cf. R.A.E.*, B **35** 88], the effect of accumulated doses or prolonged exposure was investigated. It was found that five applications of DDT at 2 lb. per acre at yearly intervals resulted in a 26 per cent. decrease in numbers of nesting

birds. In laboratory experiments, diets containing 100 parts DDT per million before or during the breeding season had little effect on the number of eggs laid by quail or of chicks hatching, but mortality among the chicks was high during the first six weeks, and less than 10 per cent. reached maturity even though the chicks themselves received insecticide-free diets. More than 80 per cent. of chicks from untreated parents survived. When DDT was included in the chicks' diet, all the progeny of the insecticide-fed parents but only 30 per cent. of those from the control group died. DDT in the diet of pheasants reduced the number of eggs and chicks produced but had only slight effect on chick viability. Aldrin and endrin were found to be up to 100–200 times as toxic as DDT to young quail and were lethal in concentrations as low as 0·5 p.p.m. Dieldrin, γ BHC (lindane), heptachlor and chlordane were also more toxic than DDT, but methoxy-DDT (methoxychlor) was tolerated for long periods at 500 or 1,000 p.p.m. All these compounds affected reproduction of both quail and pheasants by reducing production, fertility or hatchability of eggs or viability of chicks, and they reduced the growth rate of young birds.

Recommendations for minimising the hazards involved in insect control include keeping rates of application at or below the toxicity equivalent of 2 lb. DDT per acre in oil solution in forested areas to avoid significant loss of birds and of 1 lb. per acre to avoid significant loss of fish, avoiding direct application to streams and other water or to areas in which rapid leaching might occur, unless the rate of application is less than the toxicity equivalent of 0·2 lb. DDT per acre in oil solution or still less in emulsion, avoiding application during the migration, nesting and brooding periods of birds and treating insect infestations in forests before they reach upper drainage areas or cover large acreages.

Cole (M. M.), Clark (P. H.) & Weidhaas (D. E.). **Sleeve tests with malathion powders against DDT-resistant body lice.**—*J. econ. Ent.* **51** no. 5 pp. 741–742, 3 refs. Menasha, Wis., 1958.

Malathion was previously shown to be very effective against a strain of *Pediculus humanus humanus* L. resistant to DDT in tests off the host [*R.A.E.*, B **46** 19]. In the experiments here described 3 g. of a powder consisting of 1, 0·5, 0·25 and 0·1 per cent. malathion in pyrophyllite was applied to the interior of sleeves of knitted cotton cloth 1 sq. ft. in area and rubbed in, after which the sleeves were fixed to the arms or legs of volunteers. Lice of the DDT-resistant Korean strain were introduced at intervals and left for 24 hours, and it was found that the powders gave complete mortality for up to 17, 13–14, 6–7 and 3 days, respectively, and 96 per cent. mortality or over for 20–22, 13–14, 10 and 6–7 days. A standard powder of 0·2 per cent. pyrethrins and 2 per cent. sulfoxide gave complete control for ten days and 98 per cent. for 17 days, but 1 per cent. γ BHC (lindane) gave only 99 per cent. control for three days and 55 per cent. after 6–7 days. The subjects wearing the treated sleeves experienced no ill effects and showed no visible reactions or appreciable decreases in cholinesterase activity, but the amount of dust applied was only one-ninth of that normally used for the complete treatment of clothing.

Cole (M. M.) & Wilson (H. G.). **Effect of a combination of unrelated synergists on the toxicity of pyrethrins to body lice and house flies.**—*J. econ. Ent.* **51** no. 5 pp. 742–743, 4 refs. Menasha, Wis., 1958.

Laboratory experiments were carried out to determine whether a combination of two chemically dissimilar compounds as synergists for pyrethrins

would increase the toxicity of the latter more than either synergist individually. IN-930 (N-isobutyl-undecyleneamide) was combined with an equal amount of sulfoxide in tests against *Pediculus humanus humanus* L. by the beaker method [*R.A.E.*, B **34** 44] and similarly with piperonyl butoxide in tests of contact sprays against *Musca domestica* L. by the wind-tunnel method [**47** 85]. Control of *P. h. humanus* by 0·005 per cent. pyrethrins with the two synergists was no better than with sulfoxide only at an equal concentration of total synergist but was better than with IN-930 only. Sprays containing various concentrations of pyrethrins in combination with piperonyl butoxide and IN-930 were no more effective against *M. domestica* than pyrethrins with piperonyl butoxide only at the same concentration of total synergist and were very little better than pyrethrins with piperonyl butoxide at the concentration used in combination with IN-930 but more effective than pyrethrins and IN-930 only at either strength.

Laake (E. W.). **Yellow fever vectors in Dallas, Texas.**—*J. econ. Ent.* **51** no. 5 pp. 743–744, 4 refs. Menasha, Wis., 1958.

In the course of investigations of the mosquito vectors of human disease at Dallas, in north-eastern Texas, it was shown in 1955 that *Aëdes aegypti* (L.) bred there in every month from May to November inclusive. In view of the advance of jungle yellow fever, which is largely transmitted by tree-hole mosquitos of the genus *Haemagogus*, along the Atlantic coast of Central America [*cf. R.A.E.*, B **47** 94, etc.], the possibility of its reintroduction into the United States, the presence of *H. equinus* Theo. in southern Texas [**47** 148] and the existence of evidence that marsupials, especially opossums, and even possibly rodents, can maintain the virus in nature in the absence of monkeys, a survey of the mosquitos breeding in tree holes in Dallas was made in 1957, an unusually favourable year for them. The species found were *Anopheles barberi* Coq., and five other common tree-hole breeders, none of them known to carry diseases of man, and *Culex pipiens fatigans* Wied. (*quinquefasciatus*, auct.), a common local species and a vector of human encephalitis not previously thought to breed in tree holes. No species of *Haemagogus* was taken.

Brundrett (H. M.), Deer (J. A.) & Graham (O. H.). **Control of horn flies in the Rio Grande Valley of Texas with Bayer 21/199 sprays.**—*J. econ. Ent.* **51** no. 5 p. 746, 1 ref. Menasha, Wis., 1958.

As Bayer 21/199 [O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl phosphorothioate] is effective against first-instar larvae of *Hypoderma lineatum* (Vill.) when used systemically [*R.A.E.*, B **46** 165] and also controls *Musca domestica* L. by contact [**45** 174–175], tests were made in the Lower Rio Grande Valley of Texas in 1957 of its effectiveness against *Siphona irritans* (L.) with a view to its use as a summer spray against both *Siphona* and *Hypoderma*. An application of 0·25 per cent. 21/199 at about 2 U.S. quarts per animal under a pressure of 300 lb. per sq. inch to a moderately infested herd of beef cattle on 15th April, when populations of *Siphona* on other herds were increasing, repelled the flies while the hair was still wet but not after it had partly dried. No living flies could be found on the cattle about 20 hours later. Some were noted after three weeks, and there were about twice as many as before treatment after four weeks. A second application at 0·5 per cent. on 24th June also protected the cattle for three weeks but failed after four. On 7th and 8th May, three other herds were sprayed with

0·25 or 0·5 per cent. 21/199 or 0·5 per cent. methoxy-DDT (methoxychlor). The results were very difficult to assess because of the inequality of re-infestation pressure to which the various herds were exposed. The stronger spray of 21/199 acted much faster than the weaker and gave complete initial control, and control was still nearly complete after 16 days, but local populations were very heavy, reinfestation occurred and a second treatment was necessary on the 48th day. It equalled the first in initial toxicity but lost its effectiveness in 2–4 weeks. The weaker spray of 21/199 and the methoxy-DDT gave good control for seven weeks, and second applications at that time maintained almost complete control until the test ended after 30 days, but the populations of *Siphona* to which the herds were exposed, particularly the one receiving methoxy-DDT, were much lower than those against which 0·5 per cent. 21/199 was tested.

PETERS (W.) & STANDFAST (H. A.). **The susceptibility of mosquitoes of the *Anopheles punctulatus* group to chlorinated hydrocarbon insecticides.**—*Aust. J. Sci.* **20** no. 7 pp. 218–219, 6 refs. Sydney, 1958.

In the course of trials of house spraying with DDT and dieldrin against mosquitos of the group of *Anopheles punctulatus* Dön. (*A. punctulatus*, *A. farauti* Lav. and *A. koliensis* Owen) in north-eastern New Guinea, houses in a strip of coastland about 20 miles long round Wewak were sprayed with wettable dieldrin at 0·5 g. toxicant per sq. metre between 20th May and 14th June 1957. Initial reductions in mosquito populations were excellent, but Anophelines began to return after four months and the former population levels were almost reached by the end of November. To determine whether resistance to the insecticide was developing, samples of the predominant species, *A. farauti* in a village in the sprayed area and *A. koliensis* in a village three miles outside it, were caught and kept for 24 hours. The percentages dead after this time averaged 26·4 and 9·6, respectively. Females of *A. farauti* caught in mosquito nets survived in somewhat greater numbers than those caught on walls. Comparative susceptibility tests by the method of Busvine & Nash, as recommended by WHO [*R.A.E.*, B **41** 156; **46** 203], on engorged females of *A. punctulatus* caught in an unsprayed inland village about 100 miles away, *A. farauti* from the sprayed village and *A. koliensis* from the neighbouring control village showed that the LC50's of p,p′ DDT and (in brackets) dieldrin for the three species were 0·47 (0·033), 0·58 (0·035) and 0·62 (0·04) per cent., respectively. The susceptibility of all was well within the range compatible with successful field control with DDT and dieldrin and compared favourably with that of susceptible vector species in other regions. The increase in Anopheline density in the Wewak area only four or five months after spraying thus indicated the desirability of re-spraying at maximum intervals of six months, but not a decrease in susceptibility to dieldrin.

O'GOWER (A. K.). **The influence of the surface on oviposition by *Aëdes albopictus* (Skuse) and *Aëdes scutellaris katherinensis* Woodhill (Diptera, Culicidae).**—*Proc. Linn. Soc. N. S. W.* **82** (1957) pt. 3 pp. 285–288, 20 refs. Sydney, 1958.

The following is based largely on the author's synopsis. In the further laboratory experiments described [*cf. R.A.E.*, B **44** 60; **47** 186], the selection by females of *Aëdes albopictus* (Skuse) and *A. scutellaris katherinensis* Woodhill of a water container as an oviposition site was influenced by the

physical properties of its surface, namely its texture, its reflectance [*cf.* **44** 61] and the presence or absence of free water. Both mosquitos preferred free water surfaces to moist, porous surfaces, rough textures to smooth and low reflectances (black) to higher ones (grey). When the interaction of these properties was studied, both preferred a free water surface of low reflectance to a smooth, moist, porous surface of higher reflectance, but these preferences were reversed when the texture of the moist, porous surface was changed from smooth to rough. However, when reflectance and texture were studied together, a black, smooth surface and a grey, rough one were about equally acceptable to *A. s. katherinensis*, but *A. albopictus* preferred the black, smooth surface. It is concluded that the similar oviposition behaviour of the two mosquitos, particularly with regard to texture, is probably correlated with similarity in larval ecology. *A. albopictus* breeds in tree holes [**45** 133], and *A. s. katherinensis* is believed to do so also.

Webber (L. G.). **Nutrition and reproduction in the Australian sheep blowfly** *Lucilia cuprina*.—*Aust. J. Zool.* **6** no. 2 pp. 139–144, 1 graph, 13 refs. Melbourne, 1958.

A protein meal is known to be necessary for egg maturation in blowflies [*R.A.E.*, B **21** 247; **23** 143; **26** 225], and experiments described in this paper, in which females of *Lucilia cuprina* (Wied.) kept in uniformly illuminated cages at 25°C. [77°F.] and 40 per cent. relative humidity were offered different moist diets, showed that carbohydrate and salts are likewise essential for the development of eggs in this species. Casein (with salts), milk, baker's yeast, egg albumen, and gelatin with the addition of salts and *l*-tryptophan were all adequate for egg development in the presence of sucrose, but eggs developed more slowly on these foods than on liver. Egg albumen proved toxic to the flies, although egg development was well advanced in the few females that survived for three days.

It is unlikely that mammal and bird carcasses are numerous enough to form the sole source of protein for *L. cuprina* in the field in Australia, and experiments showed that pollen was not a satisfactory source. Sheep faeces have also been reported to be inadequate, but observations over a period of two years showed that the amount of protein in the faeces is related to the amount available to the sheep. Further tests showed that adequate food for the development of eggs may be provided by the faeces of sheep and other grazing animals, especially those kept on improved pastures during spring and autumn, when the pastures and consequently the faeces have a relatively high protein content. Sheep faeces in summer were inadequate, as also were Coccid and Psyllid honeydew, but a combination of the two enabled eggs to be matured in a few days. The honeydew of an aphid proved suitable for females having access to water.

Nelson (W. A.) & Qually (M. C.). **Annual cycles in numbers of the sheep ked,** *Melophagus ovinus* **(L.).**—*Canad. J. Anim. Sci.* **38** no. 2 pp. 194–199, 5 graphs, 9 refs. Ottawa, 1958.

Observations on seasonal fluctuations in populations of the sheep ked (*Melophagus ovinus* (L.)) in different parts of the world have given apparently conflicting results and have elicited different explanations [*cf.* *R.A.E.*, B **29** 52; **38** 80; **39** 200; **43** 160]. A study of the fluctuations on sheep in various physiological states was therefore made in Alberta. Ked populations were studied on barren and pregnant ewes in 1953–54, and on barren and pregnant ewes, ewes from which the ovaries had been removed,

and rams and wethers continuously from 1954 to 1957. The ewes in the first study were one year old when it was begun, whereas all sheep in the later one were obtained as lambs five months old in September 1954. The numbers of keds on wethers and on both groups of non-pregnant ewes rose consistently until they reached peak levels in January and February, after which they declined steadily until June and then remained at very low levels until autumn. This appeared to be the basic pattern. Declines were accompanied by high ked mortality. Infestations on pregnant ewes that conceived in October or November continued to increase until the lambs were born in March or April, but those on ewes that conceived in December reached peak levels at the usual time. Following parturition, numbers fell rapidly and were very low in summer. Rams maintained consistently higher infestations than all other groups except pregnant ewes throughout most of the study, and infestations on them remained longer at peak level. The numbers of keds on sheep of all groups except pregnant ewes were smaller and tended to reach peak levels earlier in the second and third years of the life of the sheep than in the first year. Meteorological data did not support the theory that the decline in numbers of keds that begins in January or February is due to low air temperatures, nor could it be attributed entirely to transfer of keds to lambs, as it has been shown that only newly emerged keds move from ewes to their lambs [**47** 197]. It is postulated that some form of host resistance to infestation develops towards the end of the first year of life and that the increases in population that occur each autumn result from a partial breakdown of this resistance.

SURTEES (G.). **The production of DDT resistance in a southern Nigerian strain of** *Aedes* (*Stegomyia*) *aegypti* **under laboratory conditions.**—*W. Afr. med. J.* (N.S.) **7** no. 2 pp. 114–116, 3 refs. Ibadan, 1958.

As it was feared that the use of insecticides against *Aëdes aegypti* (L.) in Nigeria might lead to the development of resistance to them [*cf. R.A.E.*, B **46** 109, 149–150], the effect of DDT on a local strain was investigated. All tests were made with fully-fed fourth-instar larvae [*cf.* **46** 194], reared from material collected at Ilobi, 50 miles north of Lagos, and these were exposed for 24 hours in alcohol suspensions of DDT diluted with distilled water. In initial tests, concentrations of 0·5 part per million or over gave complete mortality, and 0·01 p.p.m. gave 64 per cent. When a strain was selected by breeding from individuals that survived exposure for 24 hours to the latter concentration, mortality in five successive generations was 81·87, 86·19, 74·37, 32·68 and 2·45 per cent. The tests took about 15 weeks. The author infers that in the field, with a programme of monthly treatments against larvae, a strain of this order of resistance could develop in 4–5 months.

LEE (D. J.), FENNER (F.) & LAWRENCE (J. J.). **Mosquitoes and fowl pox in the Sydney area.**—*Aust. vet. J.* **34** no. 8 pp. 230–237, 7 refs. Sydney, 1958.

Fowl-pox occurs in most poultry-rearing areas of Australia, and vaccination is widely practised against it in commercially raised birds. Epidemics are seasonal, and the characteristic season varies in different parts of the country. The disease has occurred in all months of the year in fowls in the Sydney area, where it is widespread, but determination of seasonal prevalence there is difficult because of the high proportion of vaccinated birds. Cases were seen in the early autumn of 1953, 1954 and 1955 in private fowl-runs, and viruses indistinguishable from that of fowl-pox were recovered

from three pools of *Culex pipiens fatigans* Wied. in 1954 and from seven pools of *C. p. fatigans* and one of *Aëdes notoscriptus* (Skuse) in 1955. Collection of mosquitos at light, on human bait and in fowl runs and identification of the blood meals of many by the precipitin test indicated that, although *C. p. fatigans* was the most plentiful and generally distributed mosquito in the runs, at least ten other species probably attack fowls. Some of these are rarely seen, since they are nocturnal and do not rest in the runs by day. It is concluded that fowl-pox is probably spread from fowl to fowl by *C. p. fatigans*, but that other species may be involved in transmission and particularly in the initial introduction of the virus into a run. The tendency of the disease to occur mostly in autumn, both in Australia and in the northern hemisphere, may be related to the number of susceptible birds available, as those more than a year old are likely to have gained immunity from an earlier infection and younger ones may be protected by maternal antibody transferred in the yolk. The reservoir between epidemics is not known.

Hartwell (W. V.), Quan (S. F.), Scott (K. G.) & Kartman (L.). **Observations on flea transfer between hosts; a mechanism in the spread of bubonic plague.**—*Science* **127** no. 3302 p. 814, 10 refs. Lancaster, Pa., 1958.

There is circumstantial evidence that fleas of ground-squirrels can transmit plague bacilli from wild rodents to rats in rural areas of the western United States [*R.A.E.*, B **40** 19–20], and the development of a method for tagging fleas with radioactive cerium (^{144}Ce) [**47** 74] made possible the direct investigation of the transfer of fleas from host to host. One male and two female voles (*Microtus californicus*), marked by clipping their toes, were placed in each of a number of experimental plots simulating field conditions, in which they could establish nests; 10–40 radioactive fleas (*Malaraeus telchinum* (Roths.)) were put on certain of them. The animals caught in traps set each day were lightly anaesthetised and any fleas were removed, examined for radioactivity and returned to the hosts. Fleas were found to have transferred from one vole to another in all of five trials and were found in nests in the three trials in which nests were established. They were also eaten by the voles, as shown by the presence of radioactive faeces in the two trials during which faeces were examined. In a second type of experiment, none of 30 tagged fleas on three voles transferred themselves to three rats (*Rattus norvegicus*), kept in an adjacent enclosure, while the voles were alive. After the latter had been killed, seven fleas moved to rats that were allowed to enter the area with the dead voles, but no transfers were noted on three new voles put in the enclosure after the rats had again been removed to the adjacent one. Of 30 tagged fleas put on the new voles, 12 moved to rats in the same area. None of the 60 fleas was found in the nests of the voles, but 27 were recovered from those of the rats. Radioactivity was twice detected in the *Microtus* faeces and once in rat faeces.

Papers noticed by Title only.

Schmidt (C. H.), Bowman (M. C.) & Acree jr. (F.). **Ultraviolet determination of the insect repellent diethyltoluamide.**—*J. econ. Ent.* **51** no. 5 pp. 694–697, 2 figs., 3 refs. Menasha, Wis., 1958.

Green (N.). **Synthesis of carboxy-labeled C^{14}-N,N-diethyl-m-toluamide, an insect repellent.**—*J. econ. Ent.* **51** no. 5 pp. 707–710, 2 figs., 8 refs. Menasha, Wis., 1958.

NAKATA (G.). **The effect of sodium chloride present in the medium on the oviposition and viability of *Aëdes aegypti* Linn.** [*In Japanese.*]—*Botyu-Kagaku* **22** no. 1 pp. 74–80, 2 graphs, 11 refs. Kyoto, 1957. (With a summary in English.)

When females of *Aëdes aegypti* (L.) were offered a choice of tap-water and various aqueous solutions of sodium chloride [*cf. R.A.E.*, B **44** 164, etc.], at a constant temperature of 25°C. [77°F.], the total numbers of eggs deposited in 10 tests were 4,806, 788, 153, 29 and 8 for water and solutions of 1, 2, 4 and 8 per cent., and, in a second series, 4,576, 2,996, 1,571, 1,378 and 1,198 for water and solutions of 0·25, 0·5, 0·75 and 1 per cent., respectively. No eggs hatched in 2 per cent. sodium chloride. The percentages of eggs that hatched within 30 days in the second series were 66·4, 52, 27·7, 20·5 and 17·4, respectively, and larval mortalities in 15 days were 0, 26·7, 10, 26·7 and 100 per cent. The respective percentages of larvae that pupated were 100, 73·3, 90 and 73·3, and their mean developmental periods were 8·3, 8·6, 8·6 and 10·9 days. Adults emerged from all the pupae in water or solutions of 0·25 and 0·5 per cent., but from only 68·2 per cent. of the pupae in 0·75 per cent. sodium chloride. It is concluded that the highest concentration of sodium chloride in which *A. aegypti* can complete its development lies between 0·75 and 1 per cent.

SAKAI (S.) & ASUKA (Y.). **Insect toxicological studies on the joint toxic action of insecticides. IV. On the carrier efficiency and joint toxic action of insecticidal solvents.**—*Botyu-Kagaku* **22** no. 1 pp. 113–138, 14 graphs, 32 refs. Kyoto, 1957. (With a summary in Japanese.)

The effectiveness of organic solvents in assisting the penetration of insect cuticle by insecticides is reviewed from the literature, and the results are given of investigations in Japan in which 58 such solvents in seven chemical groups were used with γ BHC (lindane). House-flies (*Musca domestica vicina* Macq.) 3–4 days old were exposed for 30 seconds in a dusting apparatus to a dust of 0·1 per cent. γ BHC with 1 or 2 per cent. solvent on a base of clay and talc (3:2) and observed for knockdown at intervals for 24 hours at 28°C. [82·4°F.], and parallel tests were carried out in which either γ BHC or the solvents were omitted from the dusts. The knockdown caused by γ BHC without solvents was 29·25 per cent. after an hour and 33·16 per cent. after 3–24 hours. The solvents themselves mostly had little knockdown action, and they varied considerably in their effectiveness in the complete dusts, some increasing knockdown appreciably and some being useless. Except for a few of high viscosity, including the glycols, they were more effective at 2 than at 1 per cent., and the best at 2 per cent., with (in brackets) the 18- and 24-hour knockdown percentages, were isobutyl alcohol (74·8 and 75·5), cyclohexanol (72·3 and 66·9), methyl isobutyl ketone (70·2 and 72·8), methylethyl ketone (68·9 and 65·5), chloroform (67·7 and 59·8), isoamyl acetate (67·1 and 67·2), tricresol (62·3 and 53·3), ethylene dichloride (61·5 and 58·7), n-butyl alcohol (55·6 and 55·1) and trichloroethylene (58·8 and 58·3). At 1 per cent., some of the solvents rendered the dusts less effective, methyl isobutyl ketone, for example, reducing the 24-hour knockdown to 15·5 per cent.

Other tests were carried out with crickets (*Acheta* (*Gryllus*) *mitratus* (Hagenbeck)), the tarsus of one of the hind legs of these being dipped in solutions of 0·1 per cent. γ BHC in the various solvents and the time required for knockdown being noted. The solvents again affected the results, but the order of effectiveness was not the same as for the flies [*cf. R.A.E.*, A **48** 50].

In these tests, there was no regular relation between knockdown effectiveness and the boiling points of the various solvents or their solvent efficiencies for γ BHC, beeswax or house-fly lipids, but there was some relation with surface tension and viscosity. It was not possible to determine whether there was any similar joint action between the solvents and γ BHC.

DE LEÓN (J. R.). **Simuliid vectors of onchocerciasis in Guatemala.**—*Bull. World Hlth Org.* **16** no. 3 pp. 523–529, 3 refs. Geneva, 1957. (With a summary in French.)

Notes are given on the bionomics of the three species of *Simulium*, *S. ochraceum* Wlk., *S. metallicum* Bellardi and *S. callidum* (D. & S.) that have been found naturally infected with developing forms of *Onchocerca* in Guatemala and are believed to be responsible for the spread of onchocercosis [caused by *O. volvulus*] there [*R.A.E.*, B **44** 47, etc.]. The difficulty of rearing Simuliids in captivity, and the mortality induced in them when the microfilariae are ingested in large numbers prevent even an approximate evaluation of the infectivity index of the Simuliids by the study of artificially induced infections. The infectivity index was therefore estimated from dissections of adults caught at human baits in nature. The numbers dissected during September and November 1944 and those found infected with metacyclic forms and with other forms were, respectively, 1,201, 10 and 4 for *S. metallicum*, 1,182, 3 and 6 for *S. ochraceum*, 95, 1 and 1 for *S. callidum* and 7, 0 and 0 for *S. exiguum* Roub. [*cf.* **44** 47]. In September–December 1944, in a study of the site of infection in the insects [*cf.* **32** 27; **41** 39], dissections were made of 2,412, 1,968, 255 and 69 adults of *S. metallicum*, *S. ochraceum*, *S. callidum* and *S. exiguum*, respectively, and metacyclic forms were found in the Malpighian tubes of 11 individuals of the first species, five of the second and one of the third, in the thorax of three of the first and in the abdomen of three of the second; no metacyclic forms were found in the cephalic region of any of the species.

The following are the author's conclusions, based on 40,000 dissections of Simuliids captured when they were most prevalent. The metacyclic forms may pass so rapidly through the proboscis that they escape before they can be observed in dissections. The frequency with which the metacyclic forms are found in the Malpighian tubes indicates either that they can develop there or that they move there after developing in the thorax. Their presence in the Malpighian tubes causes the latter to become empty of excretory products and transparent. It is deduced that the metacyclic forms remain in the tubes until stimulated by the change in temperature brought about when the host sucks blood. The filling of the middle intestine with blood distends the somatic wall of the abdomen, making it less resistant to penetration, and the infective forms pass through it and reach the skin of the human host.

MCMAHON (J. P.). **DDT-treatment of rivers for eradication of Simuliidae.** —*Bull. World Hlth Org.* **16** no. 3 pp. 541–551, 4 figs., 1 ref. Geneva, 1957. (With a summary in French.)

Treatment of rivers and streams with DDT for the control of Simuliid larvae entails estimation of the rate of discharge of the water at a point downstream from the infested area. Methods of measuring discharge by

means of weirs, current meters and floats are described, data are given for the calculation of the appropriate dosage and methods of application are discussed. It has been ascertained that the minimum effective dosage is at the rate of 1 part DDT in 2 million parts water, delivered continuously over a period of 30 minutes, and this rate affords control for some 40 miles, according to the nature of the river [*cf. R.A.E.*, B **42** 101, etc.; **44** 70, 98]. Swamps and large pools sometimes divert or precipitate the insecticide, and it may be necessary to effect a further application below such obstacles.

Chow (C. Y.) & Thevasagayam (E. S.). **Bionomics and control of** *Culex pipiens fatigans* **Wied. in Ceylon.**—*Bull. World Hlth Org.* **16** no. 3 pp. 609–632, 21 refs. Geneva, 1957. (With a summary in French.)

Culex pipiens fatigans Wied. is widespread in Ceylon and is the main vector of *Wuchereria bancrofti* in urban areas there [*cf. R.A.E.*, B **43** 120, etc.]. Filariasis is now the most important insect-borne disease in the island, as malaria has been brought under control. House spraying with DDT (or occasionally BHC) has been carried out regularly over much of the country since 1947 against Anophelines, but many of the householders in Kurunegala municipality now object to the spraying of their houses, as it does not control *C. p. fatigans* and they question its usefulness. This may adversely affect public support for malaria-control programmes. The bionomics of *C. p. fatigans* were therefore studied in Kurunegala to determine the cause of the failure of DDT to control it; alternative methods for use against it were also sought. It breeds chiefly in polluted water in the cement catch-pits behind latrines. Laboratory investigations showed that the average duration of development from egg to adult was 9·7 days at room temperature (80·6–82·4°F.), and that of the egg and larval stages together about 8 days, and there were generally 75–114 eggs per raft. In tests, catch-pit water was preferred to tap-water for oviposition. When DDT, dieldrin or aldrin as water-dispersible powders, dieldrin or aldrin as dusts, dieldrin in 1 or 5 per cent. granules, or γ BHC was added to tap-water and to catch-pit water, all at a dosage of 0·1 lb. toxicant per acre, the addition of these insecticides increased the attractiveness of tap-water and sometimes increased and sometimes decreased or left unchanged the attractiveness of catch-pit water, but never entirely prevented oviposition in the latter. When egg-rafts were added to the trays containing catch-pit water and the insecticides, larvae completed development normally and adults were produced in the presence of DDT, a few larvae developed to adults in the presence of aldrin and BHC, though rather slowly, but all died during the first or second instars in the trays containing dieldrin. Many adults died after emergence from the insecticide-treated waters, but none did so from the control tray. All the treated waters except that containing dieldrin lost their effectiveness after a week. In houses, adults were found to rest mainly on furniture, hangings, etc., which are not normally sprayed, and most of those that settled in houses after sunrise remained there throughout the day, unless disturbed.

In an experiment in 1948 in a locality near Colombo in which DDT had not previously been used, house spraying with DDT suspension to give a deposit of 27 mg. per sq. ft. had not reduced the numbers of Culicines (mainly *C. p. fatigans*), though the results with a kerosene solution giving 60 mg. per sq. ft. and an emulsion spray giving 118 mg. had been somewhat better. In Kurunegala in September 1953, spraying with a suspension of a water-dispersible powder to give about 11 mg. γ BHC per sq. ft. gave

inconclusive results. Treatment with wettable dieldrin to give 25 and 50 mg. toxicant per sq. ft. was followed by a slight but not a satisfactory decrease, and there was a decrease at control stations also. About half the mosquitos recovered from houses sprayed with DDT or BHC were from treated surfaces, and most of these survived for more than 48 hours.

In view of these unsatisfactory or inconclusive results, larvicides were investigated. If the contents of the catch-pits could be completely removed once a week, the chief breeding places of *C. p. fatigans* would be eliminated, but in practice a small amount of the contents always remains and most of the larvae continue to develop in this. In a campaign against this mosquito, a dust containing 3 per cent. γ BHC and 1 oz. of the same dust in 1 gal. heavy diesel oil both gave satisfactory control of the larvae at first, but subsequently even a 10 per cent. formulation proved comparatively unsuccessful. In laboratory tests in which the formulations used in the oviposition tests were applied at 0·2 lb. toxicant per acre against fourth-instar larvae, the BHC powder and dieldrin dust both gave 95 per cent. kill in 24 hours, the dieldrin granules 93 per cent., the dieldrin powder 85 per cent., the two aldrin formulations 43 and 67 per cent., respectively, and the DDT powder only 40 per cent. All formulations were as good or nearly as good at 0·1 lb. per acre. The same insecticides at the same dosages gave similar results in field tests in catch-pits. However, even at 1 lb. per acre, which was tried to see whether there was any lasting effect, weekly application of γ BHC or dieldrin seemed necessary. In experiments made throughout the municipality in June–September 1954, all the breeding places of *C. p. fatigans* were mapped and were treated with BHC, dieldrin or DDT in light diesel oil at 1–4 lb. toxicant per acre; the BHC and dieldrin at 3–4 lb. per acre killed all the larvae within 1–2 days but DDT at the same dosage was not satisfactory. All catch-pits treated with 3 lb. dieldrin per acre in water emulsion and 94 per cent. of those treated with 2 lb. γ BHC per acre from a preparation in diesel oil were free from large larvae or pupae one week after treatment. Single blocks (2-in. cubes), made of local plaster of paris impregnated so as to contain 3·1 g. dieldrin or 1·1 g. BHC were unsatisfactory when placed in each pit, but those of imported plaster sometimes remained effective for 12 weeks, and a mixture of dieldrin and sawdust at 10 lb. per acre were sometimes effective for eight weeks, though bricks and sawdust generally were unsatisfactory. Dieldrin granules failed even at 20 lb. per acre. The BHC larvicide gave poor results as a dust at 5–10 lb. per acre but was satisfactory in diesel oil at 2 lb. per acre, though diesel oil alone was not effective.

Kessel (J. F.). **An effective programme for the control of filariasis in Tahiti.**—*Bull. World Hlth Org.* **16** no. 3 pp. 633–664, 1 graph, 41 refs. Geneva, 1957. (With a summary in French.)

An account is given of the organisation and achievements of a campaign for the investigation and control of filariasis caused by *Wuchereria bancrofti* in Tahiti, where the incidence of microfilarial and clinical infection is high and the chief vector is *Aëdes polynesiensis* Marks [*cf. R.A.E.*, B **42** 90–91; **44** 62–63]. In recent dissections by Bonnet & Chapman, only 1·2 per cent. of 788 females of *Culex pipiens fatigans* Wied. (*quinquefasciatus*, auct.) taken in houses in which there were carriers of microfilariae were positive for larvae of *W. bancrofti* in any stage of development and only 0·38 per cent. for the third- or infective-stage larvae, whereas 25·5 per cent. of *A. polynesiensis* from the same houses harboured larvae and 7·6 per cent. infective larvae. The procedure followed in the campaign and recommended

for future use comprised the making of surveys of the prevalence of the disease in man, of the prevalence and density of the parasite in man and of the species of mosquitos present, their significance as vectors and the bionomics of those likely to be of importance, determination of infection rates in them in nature by means of intensive mosquito surveys [**47** 59], and application of the chosen control measures. In Tahiti, these were administration of Hetrazan [1-diethylcarbamyl-4-methylpiperazine] to the population and measures directed against *A. polynesiensis*. As this is essentially a forest-dwelling mosquito, and the females rest outdoors, bite many kinds of hosts and are adaptable in their choice of breeding places [*cf.* **42** 90, 150; **46** 199] and the eggs are very resistant to drying, it is difficult to control. However, it occurs in Tahiti in large numbers close to houses that are near bush areas, has a limited dispersal range [*cf.* **43** 205] and breeds in small containers. The control measure adopted was therefore elimination of breeding places for 110 yards round each dwelling, and for this the co-operation of householders was enlisted.

The aim has been to continue Hetrazan treatment until all carriers are negative, but this is not always practicable and evidence is given that it may not be necessary. Once the treatment programme was well launched, incidence of larvae of *W. bancrofti*, particularly those in the infective stage, diminished rapidly in mosquitos caught in the field. In a district in which 1 per cent. of the population remained positive and the microfilarial density (product of the percentage of people positive and the average number of microfilariae per positive person, based on single samples of 20 cu. mm. of blood [*cf.* **44** 63]), had been reduced to 0·04, no larvae of *W. bancrofti* were found in standard dissections of mosquitos. It is thought that in a mass-treatment campaign, reduction of persons positive for microfilariae to 5 per cent., with a corresponding maximum microfilarial density of 1, should reduce transmission to a negligible minimum. There were no indications that the administration of Hetrazan to a population positive for *W. bancrofti* increases the mosquito population of the area. The importance of continuing mosquito control after the programme against microfilariae has ended is emphasised.

Freeman (P.). **The problem of the *Simulium neavei* complex.**—*Bull. World Hlth Org.* **16** no. 3 pp. 669–670, 5 refs. Geneva, 1957.

Three closely related species of *Simulium*, *S. neavei* Roub., *S. nyasalandicum* De Meillon and *S. woodi* De Meillon, live in association with river crabs in Kenya [*R.A.E.*, B **40** 5; **45** 186], and only the first, the distribution of which is restricted to a certain type of gallery forest, bites man regularly. The problem is not so straightforward in other areas. Females taken biting man at Njombe, Tanganyika, and now in the British Museum, resemble *S. nyasalandicum* in colour. No associated pupae or males are available. In a series of females from Ethiopia, coloration again approaches that of *S. nyasalandicum* but the claws resemble those of *S. woodi*. In *S. renauxi* Wanson & Lebied [**41** 29], the male genitalia are intermediate between those of *S. neavei* from Kenya and those of *S. woodi*, and the females resemble *S. neavei* in body colour and claws [*cf.* **41** 111]. The form of *S. neavei* occurring in the Sankuru District of the Belgian Congo has been shown to transmit onchocercosis [caused by *Onchocerca volvulus*] [**21** 85], and forms of it have also been proved to be or suspected of being vectors in other parts of the Belgian Congo [*cf.* **41** 111] and in Tanganyika [**30** 97] as well as in Kenya [**35** 109, etc.]. If the form or species known as *nyasalandicum* is really responsible for transmission in Tanganyika, it is also a potential danger in Kenya.

DE ZULUETA (J.). **Observations on filariasis in Sarawak and Brunei.**—*Bull. World Hlth Org.* **16** no. 3 pp. 699–705, 1 map, 1 ref. Geneva, 1957.

Many cases of filariasis were found during a malaria survey of Sarawak and Brunei in 1952–53 [*R.A.E.*, B **46** 210]; many more were probably missed, as the thick blood films under examination had been taken during the day, and *Wuchereria malayi* has nocturnal periodicity and similar periodicity has been found for *W. bancrofti* in Sarawak. *W. malayi* occurred principally along the coast and large rivers, though some cases were reported in hilly country. Differences in the prevalence of the infection among racial groups are attributed to different habits. Infection with *W. bancrofti* was found in only a few villages some 70 miles from the sea and about 500 ft. above sea-level. The source of the infection is discussed, and it is concluded that the parasite is probably native and not introduced by Chinese immigrants.

Among nearly 35,000 mosquitos dissected over a period of more than a year, from Marudi in the Lower Baram Valley, where cases of infection with *W. malayi* had been found, only one (a female of *Mansonia* sp.) contained filariae. In Leppu Leju, in the Upper Tinjar Valley, the area in which *W. bancrofti* occurred, filariae were found only in *Anopheles leucosphyrus* Dön. and *A. barbirostris* Wulp, 0·8 and 1·5 per cent., respectively, being infected. In view of the relatively greater prevalence of *A. leucosphyrus*, of which 6·7 were taken per man-hour as compared with 0·3 of the other species, it is considered the main vector of filariasis, as it is of malaria [**46** 211]. As with malaria, there was a tendency for infections to be more numerous between January and June than between July and December, but this was not noticeably correlated with an increase in vector populations or in rainfall.

KERNAGHAN (R. J.) & DAVIES (J. B.). **Field trials of the control of *Glossina palpalis* (R.-D.) by obstructive clearing.**—*Bull. ent. Res.* **50** pt. 3 pp. 449–465, 1 pl., 8 figs., 3 refs. London, 1959.

The following is based mainly on the authors' discussion and summary. Two field trials of obstruction (obstructive clearing [*R.A.E.*, B **42** 156–157; **45** 125]) as a means of controlling *Glossina palpalis* (R.-D.), in situations representative of the northern and southern Guinea savannah zones of Nigeria, are described. In neither case was complete eradication achieved, pockets of *G. palpalis* persisting at certain places along the main stream of the rivers concerned. Greater success was obtained in the smaller tributaries, which lent themselves more to obstruction. There was little penetration by *G. palpalis* for any great distance into obstructed reaches from natural ' reservoirs ' left abutting on to them, but obstruction proved to be of no value in limited ' protective ' schemes, for a significant number of flies reached the centre of a stretch of 300 yards of obstructed stream from the unobstructed ends. In neither trial was immigration of flies from elsewhere an important factor. Although, at first, the surviving fly population was very localised, there were later indications that dispersal was beginning to take place.

Mishaps that prevented success included removal of the obstructing litter by the local inhabitants for use as firewood or its destruction by floods, which produced a final effect resembling bad partial clearing [**28** 199], and the formation of arches of obstructive vegetation as a result of falls in stream level, so that tunnels were left, through which the tsetses might fly. In addition to such accidents, various factors that were found to limit the wide application of obstruction included a width of river-bed of over 10 ft. and a

depth greater than 6 ft., which were often combined with vegetation insufficient to provide successful obstruction, and the presence of wide swampy forest, through which *G. palpalis* ranges freely and without being so dependent for its survival on the river-bed, or of shallow rocky stretches with low eroded banks that may be devoid of all but certain characteristic trees and where adequate obstruction is impossible. No technical difficulties were found in carrying out obstruction, and costs were 40–50 per cent. less than for comparable partial clearing.

In view of the subsequent appearance of originally obstructed stream, and its frequent resemblance to partial clearing, the suggestion of ' destructive ' clearing is put forward, in which the top canopy would be destroyed but no effort made either to create obstruction or to clear away the fallen trees. Instead, reliance would be put on the action of the various agencies that disrupted obstruction in these trials to produce the desired final result.

It is concluded that obstruction is unlikely to become a normal method of control of *G. palpalis* in the savannah zones of Nigeria, as its success depends too much on the existence of specialised conditions.

PAGE (W. A.). **The ecology of** *Glossina longipalpis* **Wied. in southern Nigeria.**—*Bull. ent. Res.* **50** pt. 3 pp. 595–615, 6 figs., 5 refs. London, 1959.

The following is almost entirely based on the author's summary. A population of *Glossina longipalpis* Wied. was studied between November 1953 and December 1956 in savannah typical of the southern Guinea zone, close to the field station of the West African Institute for Trypanosomiasis Research at Ugbobigha, which is situated in the savannah just north of its junction with the forest belt in southern Nigeria. Regular fly-rounds were carried out, with man as bait, and an ox also during the third year. Meteorological records were taken in the savannah woodland and within a forest island; the latter is cooler and more humid than the former. Vegetation of the forest-island type, with dense thicket under high shade, is the permanent habitat of the fly, although the interior of it apparently becomes too humid in the heavy rains, when the flies move out to the edge. Seasonal pools in the savannah, encircled with rather thicker vegetation, form temporary habitats during the rains and early dry season. Transition forest and woodland savannah, when in association with permanent habitats, are used as feeding grounds. During the dry season, the flies concentrate in and around the forest island, and evacuate the woodland savannah, which they recolonise in the early rains.

Fly concentration appears to be associated with saturation deficits reaching 7 millibars or over in the savannah, whereas dispersal is associated with a saturation deficit dropping to 6 mb. or below. When the mean monthly temperature is compared with the mean fly densities in that and the succeeding month, the value associated with the greatest density is about 77°F. The optimum saturation deficit, similarly judged, is 4–5 mb.; values below 2 or above 7 mb. appear to be relatively unfavourable. These observations suggest that laboratory cultures of *G. longipalpis* should be kept at 77°F. and 85 per cent. relative humidity. Fly catches are lowest in the early rains (April). They then increase rapidly, level off in the mid-rains, and increase again rapidly to reach their peak in the early dry season (November). The decrease in catches during the dry season represents the adverse effects of high temperature and low humidity on the population, but the continuing decrease during the early rains is believed to represent the effect of fly dispersal and not a further decrease in population.

In general, catches from the fly-round carried out with an ox showed the same seasonal fluctuations in fly population as the catches carried out with man, although female flies constituted 39 per cent. of the total catch from the former and only 1·9 per cent. of the total from the latter. The catch is larger from an ox fly-round than from a man fly-round, and the percentage of hungry flies caught is greater for the former than for the latter (7·9 per cent. and 2·7 per cent., respectively). The catches from the ox fly-round are higher, in relation to those from the man fly-round, in the conventional feeding grounds, such as transition forest and woodland savannah, than in the permanent habitat. The proportion of hungry flies amongst non-teneral males caught on the man fly-round is greatest in the late dry season and early rains, after the grass fires; good visibility then facilitates hunting activity by man, and the consequent disturbance of the game may cause the fly to lose touch with its hosts. Conversely, flies are least hungry in the early dry season; by this time, they have established intimate contact with the game, the movement of which, like that of man, is limited by dense elephant grass [*Pennisetum purpureum*] 10–15 ft. high. Precipitin tests on 44 blood-meals, collected over a long period from gorged examples of *G. longipalpis*, suggest that bushbuck (*Tragelaphus scriptus*) provides the bulk of the meals, but that the red river hog (*Potamochoerus porcus*) is also of importance. Of 4,360 males of *G. longipalpis* dissected, 939 contained mature trypanosomes, 768, 170 and 1 of the infections being with trypanosomes of the groups of *Trypanosoma vivax*, *T. congolense* and *T. brucei*, respectively.

Pupae of *G. longipalpis* were found under logs in the forest island, together with pupae of *G. medicorum* Aust., *G. fusca* (Wlk.) and *G. palpalis* (R.-D.). The pupae could be found throughout the dry season and early rains, but not during the heavy rains, when the soil is sticky.

It is suggested that since *G. longipalpis* becomes concentrated in islands and riverine strips of forest when the mean monthly saturation deficit exceeds 7 mb., it might be eradicated by partial clearing of such habitats, except towards the southern, humid limit of its range, where rapid regeneration of the vegetation would make maintenance too costly.

PAGE (W. A.). **The ecology of *Glossina palpalis* (R.-D.) in southern Nigeria.** —*Bull. ent. Res.* **50** pt. 3 pp. 617–631, 4 figs., 7 refs. London, 1959.

The following is almost entirely based on the author's summary. A population of *Glossina palpalis* (R.-D.) was studied from February 1954 to January 1957 at Ugbobigha, on the northern edge of the forest belt of southern Nigeria [*cf.* preceding abstract]. A fly-round was laid out along the banks of a forested stream, running northwards from the forest into the savannah woodland, and was divided into four sections representing farmland, wide, heavy fringing forest, narrow, light and discontinuous fringing forest and wide, dense fringing forest, flooded in the rains. The fly-round was covered twice weekly, once in each direction. All tsetses caught were marked to indicate the section and date of capture and then released. No major seasonal movements of the fly population from one section to another could be detected. It was found that open farmland and the edge of forest with good visibility always yielded the highest catches, whereas catches inside dense forest were always low. Data from a fly-round used in the study of *G. longipalpis* Wied. [*cf.* preceding abstract] showed that, at all seasons of the year, *G. palpalis* may be found in small numbers throughout the savannah woodland, even in the absence of water. It also occurs in

very small numbers within the main forest belt, and in village clearings lying within this belt.

Apart from an increase in the second and third months of the rains (March–April) and a fall during the fourth and fifth months, the population tends to remain steady at a low level throughout the year. The increase in population is associated with a mean temperature of 79–80°F. and an average saturation deficit of 5·5 millibars. The decrease in population is associated with a falling temperature, but more especially with a mean saturation deficit below 3 mb. These results agree closely with those found near the northern limit of the range of the species in Nigeria [*R.A.E.*, B **42** 154–156] and in the laboratory. The favourable period for increase during the wet season lasts for four months in northern Nigeria, but only two at Ugbobigha: this is believed to account for the much lower fly density found in the humid south. Dissections of females showed no seasonal trend in the proportion pregnant and no cessation of breeding in the heavy rains (August–September). Of 3,130 flies caught, 45·5 per cent. were females, and only 3·6 per cent. of the 1,040 females dissected were found to be virgin. The comparable figures in northern Nigeria were 49·1 and 4 per cent., respectively. There is no seasonal trend in the percentage of females amongst flies caught on man at Ugbobigha. Among the non-teneral males caught, the mean monthly proportion that was hungry ranged from 8 to 22 per cent., showing no seasonal trend. Comparable figures from northern Nigeria ranged from 24 to 43 per cent. This suggests that *G. palpalis* needs food less often in the humid conditions of Ugbobigha, or possibly that game is more plentiful though there is as yet no evidence indicating that this species makes much use of game as a source of food.

Of 1,625 individuals of *G. palpalis* dissected, 2·1 per cent. contained mature trypanosomes; about two-thirds belonged to the group of *Trypanosoma vivax* and the remainder to that of *T. congolense*. There was no difference in the infection rates of males and females.

Very few pupae were found, because the fly population was low and the breeding sites widely dispersed as a result of the equable climatic conditions. The temperature of the pupal environment is considerably higher than it is in northern Nigeria. The diurnal rhythm of activity was investigated both in the dry season and the wet. In both, activity was found to increase steadily between 7 and 10.30 a.m., as the temperature rose, and to fall steadily between 3.30 p.m. and dusk; peak activity occurred at various times between noon and 3.30 p.m. The numbers caught before 11 a.m., expressed as a percentage of the day's catch, increased at seasons at which the temperature is higher. The flies were equally active in overcast weather and full sunshine, but rain reduced activity by more than half.

PAGE (W. A.). **Some observations on the *fusca* group of tsetse flies (*Glossina*) in the south of Nigeria.**—*Bull. ent. Res.* **50** pt. 3 pp. 633–646, 1 fig., 9 refs. London, 1959.

The following is mainly based on the author's summary. Observations were made on *Glossina tabaniformis* Westw., *G. fusca* (Wlk.), *G. nigrofusca* Newst. and *G. medicorum* Aust., which all occur near Ugbobigha [*cf. R.A.E.*, B **48** 39], in southern Nigeria. It was not found possible to differentiate the females of *G. tabaniformis* and *G. fusca* by the use of external characters, but the identification of the males of these two species and of both sexes of *G. nigrofusca* and *G. medicorum* is fairly easy; a simple key, based on external characters, is given. When necessary, females of

G. tabaniformis and *G. fusca* were differentiated by dissection. *G. tabaniformis*, *G. fusca* and *G. nigrofusca* usually rest in a vertical position with the head downwards, at a height of 4–6 ft. above ground or possibly lower in the case of *G. nigrofusca*, on tree trunks, stems of climbing plants, etc., with a diameter of 5 in. or less. Flies of the *fusca* group so rarely bite man or appear in the presence of man, that it is possible to remain unaware of their occurrence in forest in which they are present in large numbers [**38** 140]. Records of the occasional biting of villagers by flies of this group, kept over a period of 3½ years, showed that 13 of the 58 bites recorded occurred between 6.30 and 10 a.m., 16 between 4 and 6.30 p.m. and 18 at night. The flies that bit at night were taken by men hunting with lamps, and may have been activated by the light or by disturbance of the vegetation. All four species were represented, but *G. fusca* comprised about half, and *G. tabaniformis* nearly a third, of the total.

Fly-rounds with a Zebu bull as bait were begun in October 1955. *G. tabaniformis* and *G. fusca* were caught in good numbers, the former comprising 83 per cent. of the total catch. There appears to be a decrease in population in the late dry season (January and February) in both these species and a peak at the height of the rains. Females comprised 56 per cent. of the total catch of *G. tabaniformis* and 47 per cent. of that of *G. fusca*. The vegetation of the fly-round, which is typical secondary rain-forest as found in southern Nigeria, was analysed, and both *G. tabaniformis* and *G. fusca* were found to prefer old forest with no lower stratum, a continuous middle stratum and good upper stratum, that is to say, with good visibility beneath the trees. *G. nigrofusca* comprised only 1·1 per cent. of the catch on the fly-round, although tree-trunk searching had indicated that it was common in the area. *G. medicorum* does not inhabit the main forest belt, but was found some 5–6 miles to the north in forest islands in the savannah.

G. tabaniformis is unlikely to be of economic importance, since its rate of infection with trypanosomes is low (3·7 per cent.) and it is confined to the forest. *G. fusca* and *G. medicorum* are both of economic importance, since their infection rates are high (14·9 and 15·4 per cent., respectively) and they travel out into the savannah grassland. *G. nigrofusca* had a yet higher infection rate (26·7 per cent.), but at Ugbobigha it is confined to the forest. In places in which it frequents the savannah, as it does in Ghana, it is potentially dangerous. All four species contained trypanosomes of the groups of both *Trypanosoma vivax* and *T. congolense* and one individual each of *G. tabaniformis* and *G. fusca* was infected with trypanosomes of the group of *T. brucei*. Females of *G. tabaniformis* and *G. fusca* are more heavily infected than males. Dissection of females of *G. tabaniformis* showed 82 per cent. to be pregnant and 4·3 per cent. unfertilised. No seasonal fluctuations in the rate were apparent.

Scott (D.). **The epidemiology of human trypanosomiasis in Ashanti, Ghana (Gold Coast).**—*J. trop. Med. Hyg.* **60** no. 9 pp. 205–215; no. 10 pp. 238–249; no. 11 pp. 257–274; no. 12 pp. 302–315; 21 figs., 14 maps, 78 refs. London, 1957.

The territory of Ashanti can be divided into two parts, one to the north-east, with a dry climate and supporting woodland savannah, and the other to the south-west, with a wet climate and covered with semi-deciduous forest. *Glossina palpalis* (R.-D.) occurs throughout. In the woodland savannah, its natural habitat is close to rivers and streams, and it is particularly restricted in the dry season but increases in numbers and extends

its distribution in the wet. In the forest, it is less frequently encountered and found mainly where the canopy is broken, such as along larger streams and in clearings round villages and farms, even at some distance from water [*cf. R.A.E.*, B **48** 40]. In a transitional zone, where islands of forests are surrounded by woodland savannah, conditions are particularly suited to *G. palpalis*, with relatively open feeding grounds readily accessible from the habitat afforded by the forest patches; it is often found in great numbers where extensive farming is carried out. *G. tachinoides* Westw. is limited to the northern parts, and *G. palpalis* is undoubtedly the only important vector of sleeping sickness (caused by *Trypanosoma gambiense*) in Ashanti, since it alone has close and universal contact with man, though *G. tachinoides* may sometimes be responsible for transmission in some parts of northern Ashanti. *G. longipalpis* Wied. occurs throughout the savannah woodland, and *G. morsitans* Westw. encroaches a short distance into northern Ashanti, but both feed mainly on game and have little contact with man.

The following is based mainly on the author's discussion and summary. The recorded data on human trypanosomiasis in Ghana up to 1939, which are regarded as very incomplete, are reviewed. Until almost 1930, the disease was known chiefly from Ashanti, where it existed at a low endemic rate, probably below 1 per cent. Soon after 1930, a severe pandemic moving across West Africa affected the Northern Territories [*cf. R.A.E.*, B **40** 6, 102], where two major epidemic foci developed; Ashanti became involved, the disease appearing principally along roads. The increase in Ashanti was finally accepted as a true increase in transmission there and not, as was at first thought, the result of an increase in infected immigrants from the Northern Territories. Systematic investigation and control, which are described, were begun in 1939, and it was shown during the first decade that the disease was declining. More comprehensive studies, carried out during 1952–54, showed that the distribution of trypanosomiasis was mainly linear and related to the proximity and importance of the local roads, though in addition there were scattered but persistent foci of infection in areas in which it is supposed that human contact with *Glossina* was particularly close. Density of the vector was not the most important factor in determining the incidence of the disease, which depends on the closeness of the contact between man and fly [*cf.* **32** 134], the constancy of the contact being also most important. It is thought that clearings in the forest country contribute to the closeness and persistence of man–fly contact and, for this reason, mass-treatment of the population based on surveys is advocated, rather than vector control by the clearing of vegetation. Whereas, formerly, infected immigrants from the Northern Territories augmented the low endemicity of the disease in the forest, it is now labourers returning from the forest areas who are contributing to the infection of the Northern Territories, where the incidence of the disease, in which a satisfactory reduction had been reported by 1947 [**40** 103], has remained below 1 per cent. for some years. The expectation that control of the disease in the Northern Territories would be followed by its disappearance from the forest areas [**40** 6] has not been fulfilled.

Wylie (H. G.). **Factors that affect host finding by** *Nasonia vitripennis* **(Walk.) (Hymenoptera: Pteromalidae).**—*Canad. Ent.* **90** no. 10 pp. 597–608, 2 figs., 33 refs. Ottawa, 1958.

Mormoniella (*Nasonia*) *vitripennis* (Wlk.), parasitises many Diptera that develop in carrion [*cf. R.A.E.*, B **19** 251; **38** 82], dung and rubbish and on nestling birds [**21** 111]. The females deposit their eggs externally on

the pupa through the puparium; they then feed on exudates from the pupa, and R. L. Edwards showed that this food significantly increases the number of eggs subsequently matured [*cf.* also **36** 203]. Experiments by the present author established that the number of parasites that complete their development on a host pupa is limited by its size [*cf.* **32** 58], that supernumerary larvae die of starvation, and that fewer than 20 usually emerged from puparia of *Musca domestica* L. about 6 mm. long and not more than ten from those about 5 mm. long. Breeding is continuous when hosts are available and the temperature is sufficiently high [*cf.* **36** 202].

The factors that influence the ability of the females to find hosts [*cf.* **29** 139] were investigated in the laboratory with a stock reared continuously on *M. domestica*, the experimental hosts being *M. domestica*, *Calliphora vicina* R.-D. (*erythrocephala* (Mg.)) and *Polietes lardaria* (F.), of which the last two were reared on meat. The following is almost entirely the author's summary of the results. The females usually avoided localities where the relative humidity of the air was more than 50 per cent. [*cf.* **32** 58], and they thereby avoided habitats in which there were few suitable hosts. Though they were not attracted directly to the source of the odour of meat, they reacted to it by searching for hosts only in the area contaminated by this odour. Their movements inside this environment were random, and they apparently recognised host puparia by touch. They examined but did not pierce puparia showing emergence holes of flies or parasites; they usually pierced other puparia, but laid no eggs if the host had not pupated or was dead or if the puparium contained well-developed larvae, pupae or adults of the parasite itself. Within certain limits at least, the size of the puparium did not affect its acceptability, but fewer eggs were laid on small pupae than on large ones by a female during one attack. The inability of the females to burrow into the ground, where many potential hosts occur, and to avoid investigating unsuitable hosts seriously limits the efficiency of the Pteromalid as an agent of control.

VITTAL (M.). **Experiments on the use of insecticides in the control of fly nuisance.**—*Indian J. Ent.* **20** pt. 1 pp. 1–6, 4 refs. New Delhi, 1958.

The efficiencies of spray deposits of organophosphorus and chlorinated-hydrocarbon insecticides against flies were compared in tests conducted at Poona in cattle sheds and other premises within about 50 ft. of them. The flies concerned were presumed not to have been very different from those found in 1953 in a survey in that city, in which *Musca domestica nebulo* F. and *M. d. vicina* Macq. predominated and six other species of *Musca* were also present. Since 1951, houses had been sprayed twice a year with DDT for the control of mosquitos. Population densities were assessed by daily counts for about a week before the tests, and were expressed as fly indices consisting of the sum of three readings with a modified Scudder grill [*cf. R.A.E.*, B **38** 158] 18 in. square, placed on the floor in the sheds, and two visual counts of the flies resting on two stanchions. A preliminary series of tests carried out in March and April 1956 showed that restricting the spray to the floors and walls of the sheds up to a height of 3 ft. gave unsatisfactory results. In a second series, which was carried out in bright, sunny weather between November 1956 and January 1957, sprays were applied not only to the floors of the sheds but also to all the wall surfaces (external as well as internal) up to their full height, to stanchions, doors, windows and roof, and to all premises situated within 50 ft. of the sheds. Control was considered to be effective as long as the fly index remained below 20. In these

tests, wettable-powder sprays of DDT, BHC or dieldrin and an emulsion spray of BHC were applied to give 112, 11, 56 and 22 mg. toxicant per sq. ft., respectively. Effective control was maintained for 8 and 29 days in two tests with DDT, for 4 and 6 days in two with wettable BHC, for 5 and 22 in two with dieldrin, and for 5 days with the BHC emulsion. Organophosphorus insecticides were more persistent in their action. Diazinon as a 20 or 60 per cent. emulsion concentrate, and as a 40 per cent. wettable powder, at 18, 27 and 36 mg. toxicant per sq. ft., respectively, was effective for periods ranging from 36 to at least 49 days, except in one test at the lowest rate in which the period of effectiveness was only 12 days, and malathion as a 57 per cent. emulsion concentrate at rates of 26 and 52 mg. per sq. ft. was effective for 22–36 days and at least 46 days, respectively. All the insecticides tested gave high degrees of control for at least three days after application.

Sharma (M. I. D.) & Krishnamurthy (B. S.). **Studies on the susceptibility of *A. subpictus* Grassi, 1899 to chlorinated hydrocarbon insecticides in a Delhi State village.**—*Indian J. Malar.* **11** no. 2 pp. 231–237, 7 refs. Kanpur, 1957.

The following is substantially the authors' summary. Studies were made in 1956 of the susceptibility to chlorinated-hydrocarbon insecticides of adults of *Anopheles subpictus* Grassi and to DDT of larvae of the same species from a village in Delhi State in which deposit sprays of DDT had been used since 1947 and had failed to give control in 1956. The adults were found to be highly resistant to DDT, as compared with those from an unsprayed village, but they did not show any cross resistance to γ BHC or dieldrin. Fourth-instar larvae, obtained from the eggs of resistant females, also showed appreciable tolerance of DDT.

Ramachandra Rao (T.) & Bhatia (S. C.). **A note on the degree of susceptibility of *A. culicifacies* to D.D.T. in some parts of Bombay State.**—*Indian J. Malar.* **11** no. 3 pp. 261–270, 3 graphs, 7 refs. Kanpur, 1957.

The following is based on the authors' summary. Tests on females of *Anopheles culicifacies* Giles caught in nature in widely scattered localities of Bombay State, in some of which DDT sprays had been used for 1–8 years whereas others had never been sprayed, showed that no significant lowering of susceptibility to DDT had occurred, even in places in which sprays had been applied for the maximum period.

Patel (T. B.), Ramachandra Rao (T.) & Paranjpey (P. D.). **A pilot study on the suspension of D.D.T. spraying and the setting up of a surveillance organisation in Kanara District covering the work up to October 31, 1956.**—*Indian J. Malar.* **11** no. 3 pp. 271–292, 9 refs. Kanpur, 1957.

An account is given of the former epidemiology of malaria in the Kanara District of Bombay State, where it was transmitted by *Anopheles fluviatilis* James [*cf. R.A.E.*, B **33** 168], and of the highly satisfactory results of control operations [*cf.* **39** 55–56]. In view of these, spraying with DDT in

houses was experimentally suspended in 1956, after it had been carried out for ten successive years, and a surveillance organisation was established in June. The last round of spraying had been in June 1955. The technique used in surveillance is described, and the findings up to October 1956 are given. These showed that *A. fluviatilis* had been practically eliminated from large sections of the district. No larvae of this species were collected, in spite of intensive searching, and no adults were taken in dwellings or cattle sheds. Mosquitos of other species were reappearing in dwellings, but their numbers had not reached those that obtained before the use of DDT. Traces of DDT, which in the last three years had been applied as a wettable-powder spray, were still noticeable in several houses in July. Numbers of *A. culicifacies* Giles were also considerably reduced; only two adults were collected in houses and five in cattle sheds. In the neighbouring district of Dharwar also, *A. culicifacies* had become rare in villages that had been sprayed for the last ten years. No infections with *Plasmodium vivax* or *P. falciparum* were found in Kanara in the blood of over 1,500 people suffering from fever; one infection with *P. malariae* was seen, but was probably not freshly acquired.

Basu (P. C.). **Filariasis in Assam State.**—*Indian J. Malar.* **11** no. 3 pp. 293–308, 2 maps, 4 refs. Kanpur, 1957.

In the course of filariasis surveys in two tea-garden areas of Assam State in the first half of 1957, 3,952 people were examined. Infection with *Wuchereria bancrofti* and *W. malayi* was found to be endemic in both areas and to involve the indigenous village populations of almost all ages, as well as immigrant labourers. Mosquitos collected in human dwellings, mixed dwellings and cattle sheds included *Culex pipiens fatigans* Wied. and *Mansonia* (*Mansonioides*) *uniformis* (Theo.), of which 3,633 and 195 females, respectively, were dissected. Freshly ingested microfilariae, resembling those of *W. malayi*, were found in the stomachs of four of the females of *C. p. fatigans*, and 45 females of this species were positive for *W. bancrofti* in various stages of development, including two with infective larvae.

Sundararaman (S.), Soeroto (R. M.) & Siran (M.). **Vectors of malaria in mid-Java.**—*Indian J. Malar.* **11** no. 4 pp. 321–338, 1 map, 20 refs. Kanpur, 1957.

The following is based almost entirely on the authors' summary. The general features of the province of Central Java are briefly described, and a list is given of the 16 species of *Anopheles*, two of them represented by two forms, that have been recorded there. The species most commonly found in the coastal strip, the inland plains and the hilly terrain are indicated. *A. sundaicus* (Rdnw.), which breeds in the brackish waters of the fish ponds and lagoons in the coastal areas, and *A. aconitus* Dön., which breeds in the rice-fields, are the principal vectors of malaria. The secondary vectors of some importance are *A. maculatus* Theo., which breeds in the clear jungle streams in the hills, and *A. subpictus subpictus* Grassi, which is prevalent throughout the province. Brief accounts are given of the transmission season and of the distribution, bionomics and infectivity rates of the vectors, and the present position with regard to control by indoor spraying with DDT and dieldrin is summarised. Resistance to both insecticides has developed in *A. sundaicus* [*cf. R.A.E.*, B **46** 214, etc.], but there is no evidence of resistance in *A. aconitus*.

Sharma (M. I. D.), Krishnamurthy (B. S.) & Singh (N. N.). **Biometric studies on the susceptibility of some species of Anopheline mosquitoes to technical D.D.T., gamma B.H.C. and technical dieldrin.**—*Indian J. Malar.* **11** no. 4 pp. 401–414, 8 refs. Kanpur, 1957.

The LC50's of technical DDT, γ BHC and technical dieldrin for gravid females of four species of *Anopheles* from different parts of India have been determined since 1956 by the standard Busvine method [*cf. R.A.E.*, B **47** 86] and recorded to serve as a basis for comparison in further similar studies. Particulars of the investigations and detailed analyses of the data are given in this paper. The mosquitos examined were *A. annularis* Wulp, *A. culicifacies* Giles and *A. fluviatilis* James from an unsprayed village in Udaipur District, Rajasthan, *A. culicifacies* and *A. subpictus* Grassi from an unsprayed village in Meerut District, Uttar Pradesh, and *A. subpictus* from two villages in Delhi in which DDT sprays had been used. Mosquitos from unsprayed areas were exposed to the deposits for one hour and those from sprayed areas for 24 hours. The LC50's (as concentration percentages) ranged from 0·222 for *A. culicifacies* from Udaipur to 3·02 for *A. subpictus* from Delhi in the case of DDT, from 0·0039 for *A. culicifacies* from Meerut to 0·033 for *A. annularis* from Udaipur in the case of γ BHC and from 0·03214 for *A. culicifacies* from Meerut to 0·414 for *A. annularis* from Udaipur in the case of dieldrin.

Hohorst (W.) & Bauer (F.). **Alodan, ein neues Insekticid zur Bekämpfung tierischer Ektoparasiten.** [Alodan, a new insecticide for the control of animal ectoparasites.]—*Dtsch. tierärztl. Wschr.* **65** no. 4 pp. 93–98, 6 refs. Hanover, 1958.

Alodan is the proprietary name of a new chlorinated-hydrocarbon insecticide, 5,6-di(chloromethyl)-1,2,3,4,7,7-hexachlorobicyclo[2.2.1]heptene-2. It is a greyish-white, granular powder with a melting point of 105–107°C., stable in the presence of both acids and bases, practically insoluble in water but soluble to 3–5 per cent. in alcohols, 10 per cent. in olive oil or ether, and 40 per cent. in chloroform and other organic solvents. No irritation was caused by introducing a 10 per cent. solution of Alodan in oil into the conjunctival sac of a rabbit, or by injecting the material subcutaneously into the inner surface of a rabbit's ear or the shaved abdomen of a guineapig; similar results have been reported for alcoholic solutions. Lotions containing 0·1–0·25 per cent. active ingredient were not irritating to the skin or mucous membranes of cattle, sheep, pigs, dogs, cats and rabbits. The LD50's of solutions administered orally in a single dose to cats, rats and guineapigs were 12·5, more than 15 and 15 g. per kg. body weight, respectively. Dogs (including puppies) and fowls treated externally with solutions containing 50 per cent. active ingredient showed no side effects, and sheep and dogs bathed on three successive days in a suspension containing 1·5 per cent. were unharmed. Emulsions are more toxic than solutions; the LD50's were 8 and 0·8 g. per kg. when they were administered to rats orally or intraperitoneally, respectively, as compared with more than 15 g. per kg. for solutions administered by either route. The symptoms of acute poisoning, which are described, may not appear for several hours or even days. The effect is cumulative, and a lethal effect was produced in half the animals when 30 per cent. of the LD50 was administered to rats daily over a period of three days. On the other hand, rats given 2·5 g. per kg. orally each day for three weeks showed no side effects. The nature of its toxic action on

mammals is discussed, and its effect is considered to be due to paralysis of unstriated muscle.

Laboratory tests showed Alodan to give complete kill of a variety of insects, ticks and mites of medical or veterinary importance. Total mortality was given by the application of 3 or 5 per cent. dusts, at rates varying from 0·75 to 2 g. per sq. m., to adults of *Xenopsylla cheopis* (Roths.), *Cimex lectularius* L. and *Melophagus ovinus* (L.), various stages of *Haematopinus suis* (L.), *Damalinia* (*Bovicola*) *bovis* (L.) and *Dermanyssus gallinae* (Deg.), and adults and nymphs of *Ornithodoros moubata* (Murr.), or to the substrate; by spraying adults of *Triatoma infestans* (Klug) with a 50 per cent. preparation diluted to 0·2 per cent.; by exposing adults of *C. lectularius* and nymphs of *O. moubata* on filter paper impregnated with Alodan at 1 and 1·2 g. per sq. m., respectively; by exposing adults of *Aëdes aegypti* (L.) to deposits from an 0·06 per cent. emulsion in glasses; and by dipping various stages of *Glycyphagus destructor* (Schr.) (*cadaverum* (Schr.)) in a 0·2 per cent. emulsion. Larvae of *T. infestans* were not affected by spraying with a 0·2 per cent. solution or by a 5 per cent. powder applied to the substrate at 2 g. per sq. m.; filter paper impregnated with Alodan at 0·04 per cent. had no effect on *D. gallinae*, and unsatisfactory kills of larvae and adults of *Musca domestica* L. were given by Alodan at 0·3 per cent. in the food medium and on glass, respectively. A list is given of 31 arthropods, including fleas, lice, bugs, mange mites and ticks, that have been successfully controlled by Alodan, at least in the adult stage, and of six that were not satisfactorily controlled; this second list includes *Demodex canis* Leydig and larvae of *Hypoderma bovis* (Deg.). Full control of susceptible species was usually obtained within seven days, although *Psoroptes cuniculi* (Delafond) persisted for up to seven weeks. Preliminary tests with Alodan as a systemic insecticide, carried out on guineapigs by a single subcutaneous injection of 400 mg. per kg. daily for five days, indicated that adults of *C. lectularius* and third-instar nymphs of *O. moubata* could not be controlled in this way.

Fen (Chun-tzi). **The study of the vectors of tick-borne relapsing fever in China.** [*In Russian.*]—*Dokl. Akad. Nauk SSSR* **121** no. 4 pp. 766–768, 7 refs. Moscow, 1958.

Foci of tick-borne relapsing fever, transmitted by *Ornithodoros tholozani* (Lab. & Mégn.) (*papillipes* (Bir.)), were found in Kashgar, in the Sinkiang-Uighur region of western China, in the summer of 1956, and a survey was therefore made for ticks of this genus round Urumchi, the capital of the region, in September 1957. Numerous examples of *Argas persicus* (Oken) were found in fowl houses, but none of *Ornithodoros*. Investigations in an outlying district showed that *O. tartakovskyi* Olen. was present in burrows near ruins in the semi-desert, 94 larvae, 892 nymphs, 134 adult males and 106 females being taken in three out of about 20 of these. This species was until recently known only from the Soviet Union and has not previously been recorded in China. Batches of 30–40 examples were fed on 24 white mice, and 17 of the latter showed symptoms in 4–8 days. The disease lasted 8–14 days in the mice. Spirochaetes of relapsing fever were found in their blood, though they were not numerous, and three batches of the same ticks infected white mice by bite three months later. The strain of spirochaetes obtained was also infective for rabbits and hamsters (*Cricetus* (*Mesocricetus*) *auratus*), but not for guineapigs. In similar tests with 35 examples of *O. tholozani* collected from the nests of mice in houses in Kashgar, spirochaetes were observed for 19–21 days in the blood of guineapigs on which they fed, beginning on the sixth day.

Sinclair (A. N.). **A field trial for the control of itch mite (*Psorergates ovis*) of sheep.**—*Aust. vet. J.* **34** no. 12 pp. 405–410, 1 fig., 17 refs. Sydney, 1958.

Psorergates ovis Womersley can be controlled by dipping infested sheep in lime-sulphur diluted to contain 1 per cent. calcium polysulphides [*R.A.E.*, B **32** 177, etc.], but the effectiveness of lime-sulphur against other ectoparasites is low. Chlorinated hydrocarbons, on the other hand, do not appear to be effective against *P. ovis*, but some organic phosphates have shown promise [**47** 143]. In the field trial described, which was made in Queensland in 1956–57 with a view to developing a comprehensive formula, adult merino wethers were treated in a power spraying unit (sheepshower) with diazinon alone (from an emulsion concentrate), dieldrin alone (from a wettable powder) and a mixture of dieldrin and lime-sulphur, and the effect on *P. ovis* and body lice [*Damalinia ovis* (Schr.)] was observed. The sheep were treated for two minutes with the top nozzles only and for the next two with the bottom nozzles only, and the sump, which had a capacity of 500 gal. was thoroughly cleaned at the end of each day. Skin scrapings taken over a period of 12 months after treatment from four previously infested, marked sheep among about 1,750 treated with a mixture of lime-sulphur (1 per cent. calcium polysulphides) and 0·0125 per cent. dieldrin did not show any mites, but mites were found in scrapings taken over a similar period from five previously infested sheep among about 1,750 treated with 0·04 per cent. diazinon and from four among about 500 treated with 0·0125 per cent. dieldrin alone. The concentrations given are those at which the sump of the unit was charged, and it is assumed that the method used ensured that concentrations did not fall below half the charging concentration during treatment. All treatments eradicated *D. ovis*. Wool from mite-infested sheep showed considerable damage, but wool from sheep treated with lime-sulphur was apparently normal at the following shearing. Further treatment of several thousand sheep with lime-sulphur in spraying units of various types and reports of treatment of many thousand more indicate that, provided the technique is efficient, the treatment is not dangerous to sheep. Investigations of reports of deaths indicated that fatalities could usually be attributed to ingestion of the fluid. This is apt to occur when weak sheep are overcrowded during treatment and when both sets of nozzles are used simultaneously.

Roulston (W. J.) & Schuntner (C. A.). **Depletion of gamma isomer from benzene hexachloride cattle-dipping fluids.**—*Aust. J. agric. Res.* **9** no. 3 pp. 403–420, 4 figs., 13 refs. Melbourne, 1958.

The loss of the γ isomer in relation to that of total BHC from cattle-dipping fluids was examined in southern Queensland in 1953–54, and the following is substantially the authors' summary of the results. A differential loss of the isomers was demonstrated, the concentration of the γ isomer decreasing faster than that of total BHC. Parallel with the reduction in content of γ BHC, the toxicity of the fluid to *Boophilus microplus* (Can.) also decreased. This depletion of the γ isomer occurred not only in field dipping vats in use, but also during laboratory storage of dipping fluid contaminated with animal waste products and soil. A decrease in the concentration of γ isomer was always accompanied by a chloride increase, which was evidence of at least a partial breakdown of the BHC, but the chloride increase was not a quantitative measure of depletion of γ isomer in samples of field dips. Autoclaving failed to prevent depletion in subsequently stored samples, and refluxing BHC in suspensions containing cattle dung produced a rapid destruction of the γ isomer and a large chloride

increase. Over certain ranges, the rate of depletion was related to both temperature and dung concentration. When suspensions of BHC and dung were adjusted to a number of different pH values and stored, no decrease in the concentration of the γ isomer occurred in those with a pH of 4 or less. The addition of certain chemicals also reduced the rate of depletion, and this was generally associated with a lowering of the pH. This finding suggests a practical method of preventing depletion of γ BHC in cattle-dipping vats.

Sen (P.) & Das Gupta (S. K.). **"Dyar's Law" in the determination of larval instars in mosquitoes.**—*Bull. Calcutta Sch. trop. Med.* **6** no. 2 pp. 69–70, 2 refs. Calcutta, 1958.

It is shown that Dyar's law, which was originally propounded for distinguishing the instars of Lepidopterous larvae by measurement of head widths [*cf. R.A.E.*, A **17** 178] and was later found to be applicable to *Culicoides* [B **38** 48] is applicable also to Culicine larvae. There was close correspondence between the observed head widths of larvae of *Culex pipiens fatigans* Wied. reared in the laboratory and the head widths calculated according to Dyar's law, the growth ratio being 1·4. This would provide a useful means of determining the instars of mosquito larvae in experimental work where the actual moults have not been noted.

Mengle (D. C.). & Casida (J. E.). **Inhibition and recovery of brain cholinesterase activity in house flies poisoned with organophosphate and carbamate compounds.**—*J. econ. Ent.* **51** (1958) no. 6 pp. 750–757, 5 figs., 28 refs. Menasha, Wis., 1959.

The following is based almost entirely on the authors' abstract. Three carbamates, a sulphamate and 17 organophosphates were topically applied in acetone to female house-flies (*Musca domestica* L.) to determine the correlation between toxicity, symptoms and *in vivo* inhibition of brain-cholinesterase activity [*cf. R.A.E.*, A **38** 317]. The compounds were applied at the predetermined LD50, except for the sulphamate, of which a lower dosage was used. Flies that survived treatment with any of the compounds showed hyperactivity, paralysis and definite brain-cholinesterase inhibition before they recovered. Except in the case of exposure to Isolan (one of the carbamates), the brain-cholinesterase recovered completely within 1,280 minutes, and with several compounds the recovery was complete 80 minutes after treatment. The time of the highest rate of mortality and of paralytic symptoms in the survivors was usually closely associated with the time of maximum enzyme inhibition. With malathion, which was the chief exception, the greatest paralysis and mortality occurred after the cholinesterase activity had recovered considerably.

By assaying the brain-cholinesterase of phosphate-treated flies at varying substrate concentrations, it was found that a shift occurred in the optimum substrate concentration at the stage of hyperactivity and early paralysis. This might be due to a transitory competitive stage in the cholinesterase inhibition preceding phosphorylation of the enzyme and the dephosphorylation involved in recovery. Alternative explanations are suggested.

Neel (W. W.). **Field tests with systemic insecticides for the control of cattle grubs.**—*J. econ. Ent.* **51** (1958) no. 6 pp. 793–795, 8 refs. Menasha, Wis., 1959.

The effectiveness of three systemic insecticides in controlling *Hypoderma lineatum* (Vill.) was compared in Mississippi in 1957–58. When applied to

test groups of cattle in three localities in the late summer or early autumn, Dow ET-57 [purified O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate] administered in a bolus at 110 mg. per kg. body weight and Bayer 21/199 [O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl phosphorothioate] administered as a 0·5 per cent. wettable-powder spray at 2 U.S. quarts per adult animal were equally effective in reducing the numbers of larvae in the backs, and both were significantly better than dimethoate administered at 10 mg. per kg. in a bolus or by intramuscular injection. The groups treated with dimethoate, however, had significantly fewer larvae than those that received no treatment. The average numbers of larvae per animal in the four test herds were 0·2–2·6 in the groups treated with ET-57 and Bayer 21/199, 2–7·6 in those treated with dimethoate, and 11–16·1 in those untreated.

The treated cattle showed no significant gain in weight when compared with the untreated ones, possibly because the infestations in the latter were fairly low. In one of the localities, half the animals received phenothiazine for the control of helminths, and they, whether treated with insecticide or not, gained weight significantly.

HARGETT (L. T.) & TURNER jr. (E. C.). **Horn fly control by the use of insecticidal dusts in self-applicating devices.**—*J. econ. Ent.* **51** (1958) no. 6 pp. 795–798, 2 figs., 3 refs. Menasha, Wis., 1959.

Excellent control of horn-flies (*Siphona irritans* (L.)) on beef cattle has been obtained of recent years by the use of cable-type back rubbers treated with oil solutions of chlorinated-hydrocarbon insecticides [*R.A.E.*, B **42** 188; **47** 101, etc.]. The results of treating the cables with dust-diluted insecticides were examined in 1956 and 1957 in Virginia and compared with those of treatment with oil-diluted insecticides. A conventional triangular frame was installed, and either 0·75 lb. dust was poured into each burlap sack before it was wrapped round the wire and a further 0·25 lb. was added in the crease after half the sack had been wrapped into place or the sacks were saturated with the insecticide in oil. In a preliminary experiment in 1956, 10 per cent. toxaphene dust gave good control for the three weeks of the test. In further experiments in 1957, satisfactory control (60 horn-flies, or fewer, per animal at each observation) was given for averages of 7·3, 16, 5, 3, 5·7 and 16 weeks by back rubbers treated in the manner described with 5 per cent. toxaphene, 5 per cent. chlordane and 1 and 2 per cent. Bayer 21/199 [O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl phosphorothioate] in dusts and with 5 per cent. toxaphene and chlordane in oil, respectively. Four monthly treatments resulted in satisfactory control for 13 weeks with the toxaphene and chlordane dusts and for 14 and 15 weeks with the toxaphene and chlordane oil solutions, respectively. Rainfall had some effect on the control given by the dusts but not more than it did on the oil solution; it had more effect on the toxaphene than on the chlordane treatments, the latter being very little affected.

A conventional-type back rubber is not practicable for treating dairy cattle, as it would have to be moved each time the cattle were transferred to a fresh pasture. A modification was therefore devised in which a heavy chain was hung across the cattle walk leading to the dairy barn; each end was fastened to a screw hook at a height of about 4½ ft., and the centre hung 32 in. above the ground. The chain was wrapped in treated sacks, and the cattle passed under it twice a day. Horn-flies were kept at 50 per animal or less for 8 and 5·5 weeks by dusts of 25 and 10 per cent. methoxy-DDT (methoxychlor), respectively, for 4·5 weeks by 5 per cent. methoxy-DDT in oil and for 3·5 weeks by a dust containing 1 per cent. Bayer 21/199.

Further research is needed as to the possible amount of residue persisting in the meat and milk of animals treated in these ways. At present, only toxaphene, methoxy-DDT and DDT may be recommended for use in oil on the backs of beef cattle and only methoxy-DDT in dusts on the backs of lactating dairy cows.

LaBrecque (G. C.), Wilson (H. G.) & Gahan (J. B.). **Synergized pyrethrins and allethrin baits for the control of resistant house flies.**—*J. econ. Ent.* **51** (1958) no. 6 pp. 798–800, 2 refs. Menasha, Wis., 1959.

In Florida, 1:10 mixtures of pyrethrins or allethrin with piperonyl butoxide as a synergist were compared with trichlorphon (Dipterex) in dry sugar baits for the control of organophosphorus-resistant house-flies (*Musca domestica* L.) [*cf. R.A.E.*, B **47** 85; **48** 19]. In the laboratory, pyrethrins and allethrin (both with the synergist) and trichlorphon at 0·01 per cent. gave 28, 5 and 100 per cent. kill of susceptible flies, respectively, in 24 hours, and 23, 3 and 0 per cent. kill of flies of the malathion-resistant Grothe colony. Pyrethrins at 0·5 and 1 per cent. gave nearly as good a kill of the resistant flies as did 0·1 and 0·2 per cent. trichlorphon and gave better knockdown, but allethrin was not quite so effective. Field tests were carried out in central Florida with the same preparations, in unscreened dairy barns infested with flies that previous tests had indicated to have low or moderate resistance to organophosphate baits. The baits were formulated as before and sifted on floors and entrances of feed and milking premises where the flies congregated, and the results were estimated by counting the flies that landed and fed over two minutes after prescribed intervals on strips of cloth saturated with 50 per cent. malt solution. Percentage reductions of 98–99 and 26–37 were caused after 10 minutes by single applications of baits containing 0·05 per cent. pyrethrins or allethrin and 1 per cent. trichlorphon, respectively. The results after 24 hours were more variable, but concentrations as low as 0·05 per cent. pyrethrins and 0·25 per cent. allethrin were equal to or more effective than trichlorphon at 1 per cent. When baits were applied on five days a week for three weeks in six dairy barns, nearly all the treatments with 0·1 per cent. pyrethrins reduced the numbers of flies coming to feed on the malt solution after ten minutes to less than 20 per cent. of the pre-treatment counts for each day, which were very variable; the reductions in two of the barns were to less than 8 per cent. throughout the test. The 24-hour reductions, based on the count before the first application, were high in all the barns except one, which was exceptionally large and heavily infested. Baits containing 0·1 per cent. allethrin, though not so effective as pyrethrins, gave more than 80 per cent. reduction after ten minutes in 49 out of 58 applications in four dairy barns. The 24-hour reductions were somewhat lower than with pyrethrins and about the same as with 1 per cent. trichlorphon. The latter was not highly effective in ten minutes, reducing populations by more than 80 per cent. on only four out of 45 occasions. No bait applications were made on Saturday or Sunday, and on only four occasions with pyrethrins and one with allethrin was the control above 80 per cent. on the following Monday.

Plapp (F. W.) & Casida (J. E.). **Hydrolysis of the alkyl-phosphate bond in certain dialkyl aryl phosphorothioate insecticides by rats, cockroaches, and alkali.**—*J. econ. Ent.* **51** (1958) no. 6 pp. 800–803, 15 refs. Menasha, Wis., 1959.

The following is based on the authors' abstract. The nature of the products formed by *in vitro* and *in vivo* hydrolysis of diazinon, parathion,

methyl-parathion, Dow ET-57 [purified O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate], Chlorthion and dicapthon was studied. All these dialkyl aryl phosphorothioates were hydrolysed at both the alkyl-phosphate and the aryl-phosphate bonds [*cf. R.A.E.*, B **47** 87]. Alkyl-phosphate hydrolysis was proportionately greater with the dimethyl (the last four) than with the diethyl phosphorothioates (the first two) in rats and under the *in vitro* alkaline conditions employed. In rats, the percentage of hydrolytic metabolites formed by cleavage of the alkyl-phosphate bond varied directly with the amount of insecticide administered. Such hydrolysis appeared to be an alternative mechanism for detoxification in mammals when the dosage was too great to be metabolised through hydrolysis at the aryl-phosphate bond; but it did not seem to be a major factor in the large differences in toxicity among the various phosphorothioates. In cockroaches (*Periplaneta americana* (L.)), there was very little alkyl-phosphate hydrolysis of any of the compounds but methyl-parathion, and the fact that there was less than in rats, particularly with the dimethyl compounds, suggests that this method of detoxification may be more important in mammals than in insects. Differences were also noted between rats and cockroaches in the rate of oxidation of the various compounds or their hydrolytic metabolites.

Wade (L. L.) & Colby (R. W.). **Treatment time with Dow ET-57 for cattle grub control.**—*J. econ. Ent.* **51** (1958) no. 6 pp. 808–809, 6 refs. Menasha, Wis., 1959.

As it had been established that a single oral dose of Dow ET-57 (purified O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate) administered before *Hypoderma* larvae encyst in the backs of cattle would destroy the migrating stages [*R.A.E.*, B **46** 54, 88], further tests were carried out to determine the dosage necessary and the best time to administer the compound [*cf.* **46** 139; **47** 168]. The tests were made on two herds divided into groups, at Bragoria in southern Texas. Each month for seven months beginning on 3rd May 1956 (about one month after the last *Hypoderma* larvae were seen in the backs of cattle in this locality), two of the groups were given oral doses of 75 or 100 mg. ET-57 per kg. body weight, and each month for six months one previously untreated group received 75 mg. ET-57 and 100 mg. purified phenothiazine per kg. One group from each herd was kept as an untreated control. The ET-57 was administered as an oral drench prepared by mixing a 25 per cent. wettable powder with water. In the first herd, which received the May, June and July treatments, untreated cattle had an average of nine larvae each and the various treatments effected reductions of 79–100 per cent. The second herd, which received treatments during the remaining months, had an average of 17·4 larvae per head in the controls and the treatments effected reductions of 79·5–96 per cent., except that with 100 mg. ET-57 in August, which reduced encystments by only 45·8 per cent. The percentages of cattle infested in the treated and untreated groups were 0–50 and 86, respectively. There was no apparent difference in effectiveness between the three treatments or between treatments made in the different months, and the results indicated that treatment may be made at any time during the season after all activity of adult *Hypoderma* has ceased and before the larvae begin to encyst in the backs of the cattle, and also that a dose somewhat below the recommended 100 mg. per kg. will give a high degree of control.

Piquett (P. G.) & Gersdorff (W. A.). **Screening tests with some synthetic compounds for toxicity to house flies when applied as space sprays.**—*J. econ. Ent.* **51** (1958) no. 6 pp. 791–793, 4 refs. Menasha, Wis., 1959.

Gersdorff (W. A.) & Piquett (P. G.). **The toxicity of certain alkoxybenzyl esters of chrysanthemumic acid in comparison with allethrin and pyrethrins as house fly sprays.**—*T. c.* pp. 810–812, 2 refs.

In the first paper, the results are given of preliminary evaluations by the Campbell turntable method [*R.A.E.*, B **26** 246] of the effectiveness of 111 synthetic compounds when applied as space sprays for control of *Musca domestica* L. All were prepared as solutions in a 1:3 mixture of acetone and refined kerosene at 20 mg. per ml., and 29 gave mortalities ranging from 12 to 100 per cent. in a day. Further study of 18 was considered warranted by their toxicity or their structure or both. All these were esters of chrysanthemic acid or a closely related cyclopropanecarboxylic acid, and they included several alkoxybenzyl esters; their toxicity varied from 10 to 33 per cent. of that of pyrethrins.

Further results with alkoxybenzyl esters of chrysanthemic acid are given in the second paper. The esters were of high purity, and allethrin and pyrethrins were used as standards of comparison. The most toxic of the new compounds were the m-isopropoxybenzyl, m-allyloxybenzyl and m-ethoxybenzyl chrysanthemates, which were, respectively, about 22, 14 and 9 per cent. as toxic as allethrin and 68, 43 and 29 per cent. as toxic as pyrethrins at the 50 per cent. mortality level when tested on the turntable. The o- and p-isomers of the allyloxybenzyl and ethoxybenzyl esters, the only compounds of which all the isomers were tested, were much less toxic than the m-isomers, and the o-isomer was more toxic than the p-isomer; with the propoxybenzyl esters also, the m-isomer gave better results than the p-isomer. The three p-derivatives were practically non-toxic at the concentration tested (30 mg. per ml.). A similar advantage of the m- over the p-isomer was shown for two methoxybenzyl and sec.-butoxybenzyl esters in the tests reported in the first paper. The knockdown value of the compounds was much inferior to that of allethrin or pyrethrins.

Anthony (D. W.) & Richey (D. J.). **Influence of black fly control on the incidence of *Leucocytozoon* disease in South Carolina turkeys.**—*J. econ. Ent.* **51** (1958) no. 6 pp. 845–847, 6 refs. Menasha, Wis., 1959.

Experiments were carried out in 1955 in Jasper County, South Carolina, to determine whether the disease caused in turkeys by *Leucocytozoon smithi* could be eradicated or its incidence reduced by control of the Simuliid vectors [*cf. R.A.E.*, B **45** 42–43]. Plots of about 11 and 4 sq. miles in area, each containing a turkey farm, were sprayed with 5 per cent. DDT in oil, applied from aircraft in bands across the streams at 200-yard intervals in March before the foliage had become heavy. The nearest untreated breeding places were 8½ miles from the turkey pastures in the large plot and 2½ miles from those in the small one. *Simulium congareenarum* (D. & S.) and some species not known to feed on turkeys were breeding in the streams in the two months preceding treatment, and a few adults of *S. congareenarum* were collected from the turkeys. Almost complete control of larvae and pupae was obtained for two weeks and 72 and 68 per cent. control in the third and fourth weeks in the larger plot, and dry weather practically eliminated breeding during the following eight weeks. No Simuliids were seen on turkey poults put on the pasture four weeks after treatment in spite of observations carried out twice, and later four times, daily, but infections with *L. smithi* were evident after two weeks' exposure and involved 80 per

cent. of the birds after seven weeks. Other blood-sucking Diptera collected from the turkeys included *Culicoides* spp., *Aëdes* spp., *Diachlorus ferrugatus* (F.) and *Chrysops univittata* Macq. In the smaller plot, 95 per cent. control of larvae was obtained in the first and second weeks and 87 and 88 per cent. in the third and fourth weeks, and dry weather kept breeding at a low level thereafter. However, pupae of *S. slossonae* D. & S., an important vector [*cf.* **45** 43], and *S. congareenarum* were collected in nearly every week of the study, and a few adults may have been available to attack the turkeys, though none was seen at the times when the weekly blood samples were taken. Poults were put in the plot three weeks after treatment, but were kept in an enclosed shelter for two weeks. After this, they were put on the pasture, and infection with *L. smithi* was diagnosed in smears two weeks later and involved all the turkeys by the sixth week.

Roberts (R. H.), Radeleff (R. D.) & Kaplanis (J. N.). **Bioassay of the blood from cattle treated with Am. Cyanamid 12,880.**—*J. econ. Ent.* **51** (1958) no. 6 pp. 861–864. Menasha, Wis., 1959.

The following is based on the authors' abstract. Dimethoate, labelled with radioactive phosphorus (^{32}P) or unlabelled, was administered by the oral, intramuscular or intravenous route to cattle, and their blood was taken at stated intervals following treatment and fed to *Stomoxys calcitrans* (L.). The amounts of dimethoate in the blood determined by radiometric measurement of the labelled compound were lower than those suggested by the bioassay. The blood was found to contain an unknown metabolite (or metabolites) of dimethoate, and this was about 40 times as toxic to *Stomoxys* as the parent compound. In view of its early appearance the metabolite might be the oxygen analogue of dimethoate and it increased relatively to the latter throughout the period for which both were present in the blood. Neither could be detected in the blood after 24 hours. The toxic materials were detectable for a longer period when the parent compound was administered orally than when it was given by intramuscular or intravenous routes.

Edmunds (L. R.), Hahl (R. G.) & Wesley jr. (C.). **An evaluation of the physical characteristics and biological effectiveness of plastic coated glass fiber insect screens.**—*J. econ. Ent.* **51** (1958) no. 6 pp. 864–867, 1 fig., 4 refs. Menasha, Wis., 1959.

In view of complaints of premature failure of the plastic or metal screens used to exclude insects at U.S. military bases in various parts of the world, owing to shrinking, expansion or corrosion, screens made of glass fibre coated with plastic were tested. The five samples ranged in weight from 2·5 to 5 oz. per sq. yard; they had 18 × 14 or 18 × 18 meshes per inch, and the diameter of the glass yarn was 11 mils. In the tests, the pressure required to break the dry materials averaged 147–235 lb. per sq. in.; they lost 34–84 per cent. of their initial strength when wet, but returned to 82–100 per cent. of it after seven days of immersion and two of drying. Three samples gained in strength, one was unchanged and one lost strength after exposure to a temperature of 165°F. for six months, and two failed and three showed no evidence of cracking or flaking after 24 hours at −65°F. The screens did not become corroded and were not seriously affected by natural weathering in various climates for eight months. The fibre coating was susceptible to charring, but not the underlying fibre.

When caged in or with the materials, *Blattella germanica* (L.), *Periplaneta americana* (L.), *Blatta orientalis* L. and *Melanoplus* spp. did not

chew through the screens, but *Acheta assimilis* F. chewed through all of them, and the larvae of *Tenebroides mauritanicus* (L.) passed through without damaging them. Resistance to the growth of mildew was satisfactory in all but one sample. Screens of 18 × 18 mesh excluded *Aëdes aegypti* (L.) and most other insects and permitted enough air to circulate for satisfactory ventilation [*cf. R.A.E.*, B **46** 157]. Screens of coarser mesh were unsatisfactory. Painting them with 5 per cent. DDT in kerosene, xylene or water or with a mixture of 5 per cent. DDT and 2 per cent. chlordane caused no damage.

Young (R. G.). **Dehydrogenase systems from fat body of susceptible and chlordane resistant** *Blattella germanica* **(L.).**—*J. econ. Ent.* **51** (1958) no. 6 pp. 867–869, 16 refs. Menasha, Wis., 1959.

The following is substantially the author's abstract. The presence and levels of malic dehydrogenase with diphosphopyridine nucleotide as a coenzyme and of glucose-6-phosphate dehydrogenase and 6-phosphogluconate dehydrogenase with triphosphopyridine nucleotide were established in the fat-body of cockroaches (*Blattella germanica* (L.)) of a normally susceptible and a chlordane-resistant strain. The method used was spectrophotometric measurement of the enzymatically reduced nucleotides. A statistically significant difference between males of the susceptible and resistant strains was found for malic dehydrogenase. It is not known how the difference is related to resistance.

DeFoliart (G. R.), Glenn (M. W.) & Robb (T. R.). **Field studies with systemic insecticides against cattle grubs and lice.**—*J. econ. Ent.* **51** (1958) no. 6 pp. 876–879, 12 refs. Menasha, Wis., 1959.

In tests in Wyoming in 1957–58, 270 calves were treated orally with single doses of systemic insecticides in bolus form. Calves that had been born in the previous spring were used in all tests except one, and in that calves 2 years old were used. Dow ET-57 [purified O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate] at 85 or 110 mg. per kg. body weight and O-methyl O-(4-tert.-butyl-2-chlorophenyl) methylphosphoramidothioate (Dowco 109) at 10 and 15 mg. per kg. gave consistently high kills, often exceeding 90 per cent., of *Hypoderma lineatum* (Vill.) and *H. bovis* (Deg.) in the backs of the animals. They appeared to be as effective at the lower dosage as at the higher and equally effective against both species. Dimethoate gave only erratic control at 10 and 15 mg. per kg. None of the three, when given orally, killed all cattle lice, but dimethoate gave higher kills than the other two, the species present in this case being *Solenopotes capillatus* End. and *Linognathus vituli* (L.). Post-treatment symptoms were seen in calves of four out of five herds involved but could not be associated with feeding régimes or with the periods that had elapsed since weaning.

When added to the feed of four groups, each of 40 calves, Dowco 109 at 2, 7·5 and 15 mg. per kg. for ten days, two days and one day, respectively, and ET-57 at 55 mg. per kg. for two days, caused reductions of 61–82 per cent. in *Hypoderma* larvae, and poor feeding by a few calves in the abnormal conditions of the test is thought to have accounted largely for the fact that the result was not better. Eight of the calves of the first group were examined for lice; all were still infested, four of them heavily. Again, transitory post-treatment symptoms were seen in many calves.

In tests of sprays applied to give complete coverage, Bayer 21/199

[O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl phosphorothioate] at 0·25 and 0·5 per cent. from wettable powder provided excellent control of lice for at least five months, and Dowco 109, also from a wettable powder, provided good louse control at the same concentrations for a period of from three to more than four months. Neither gave satisfactory control of *Hypoderma* larvae under the test conditions, but each gave about 80 per cent. control in one test at a concentration of 0·5 per cent. No toxic symptoms were noticed in sprayed cattle.

Ascher (K. R. S.). **Enhanced susceptibility of a DDT-resistant strain of houseflies towards alkyl and aryl bromoacetates.**—*Riv. Parassit.* **18** no. 3 pp. 185–197, 14 refs. Rome, 1957.

Bettini (S.), Boccacci (M.) & Natalizi (G.). **A comparative study on the speed of action of some halogen-containing thiol alkylating agents on resistant house flies.**—*J. econ. Ent.* **51** (1958) no. 6 pp. 880–882, 5 graphs, 6 refs. Menasha, Wis., 1959.

It is recorded in the first paper that, earlier work having shown a strain of *Musca domestica* L., highly resistant to DDT, to be affected more quickly than a normal strain by stomach poisoning with solutions of alkali bromides [*R.A.E.*, B **44** 15], tests were made of the contact toxicity of chloro-, bromo- and iodoacetic acids and some esters of bromoacetic acid to a DDT-resistant and a normal strain of *M. d. vicina* Macq. from Israel [**45** 1] and of some of the esters to a multi-resistant and a normal strain of typical *M. domestica* of Swiss origin [**42** 193]. The acids appear to act, both in vertebrates and invertebrates, by alkylating, and therefore inhibiting, thiol enzymes, and the inhibition of triosephosphate dehydrogenase seems to play a major part in invertebrates [*cf.* **45** 139, 146]. As bromoacetic acid and its esters would not only inhibit thiol enzymes of resistant house-flies but also release bromide ions, which are toxic to the flies, it was hoped, through release of these ions at an adequate site of action, to bring about a faster knockdown in such flies than in normal ones. It was soon evident that bromoacetic acid itself could not be used to produce long-lasting deposits, on account of its high volatility, and esters were prepared that would have lower volatility and improved penetration (through the introduction of liposolvent groups). As both aliphatic and aromatic esterases are present in the tissues of house-flies, it was assumed that the esters would be hydrolysed within the flies, yielding bromoacetic acid.

In the tests, flies were kept in petri dishes in constant tarsal contact for two hours with treated surfaces, comprising either filter paper, treated one hour previously with solutions in a 1:2 mixture of olive oil and acetone in the case of the acids, or the glass itself, treated with acetone solutions in the case of the esters. When the two strains of *M. d. vicina* were exposed at 25°C. [77°F.] to the acids at rates of 2–10 g. per sq. m., contact effectiveness was found to decrease in the order bromo-, iodo- and chloroacetic acid and α-bromopropionic acid, and the resistant strain showed a quicker knockdown than the normal one on exposure to bromoacetic acid and α-bromopropionic acid. No such tendency was found with a strain resistant to γ BHC. Tests with bromoacetic acid at 2 g. per sq. m. and at three temperatures (25, 28 and 31°C. [77, 82·4 and 87·8°F.]) showed a higher knockdown at higher temperatures and demonstrated that the responses of the two strains of *M. d. vicina* remained different at the different temperatures. There was no difference in the responses of the normal and resistant strains to iodoacetic acid at 31°C. The change in response with temperature cannot be ascribed to increased fumigant action at higher temperatures

since such action was strongly reduced through solution in olive oil and absorption of the deposit by the filter paper, was at most only slight within two hours, even at 10 g. per sq. m., and was, moreover, stronger against the normal than against the resistant strain.

Among the higher esters of bromoacetic acid, n-decyl, lauryl (n-dodecyl), myristyl and cetyl bromoacetate had a certain lasting contact action, the best initial knockdown being shown by lauryl and the longest action by cetyl bromoacetate. Their molecular weights ranged between about 285 and 365 and were thus of the same order as those of lasting contact insecticides among the chlorinated hydrocarbons [*cf.* A **37** 481]. However, their action was too weak and short-lived to be of any practical value. Deposits of lauryl, myristyl and cetyl chloroacetate, 24 hours old, gave no knockdown at all within two hours of exposure. Among aromatic esters, the order of decreasing activity was p-bromophenyl, p-chlorophenyl, benzyl and phenyl bromoacetate, but the contact action of all these was very short-lived. Lauryl, cetyl, benzyl, phenyl and p-chlorophenyl bromoacetate gave better knockdown of the resistant strain than of the normal one. As regards the vapour phase, the order of decreasing activity was p-chlorophenyl, p-bromophenyl and benzyl, while phenyl, lauryl, myristyl and cetyl bromoacetate were practically inactive. When the esters were tested against the two strains of *M. d. domestica*, the level of knockdown achieved on tarsal contact was about the same as with the two strains of *M. d. vicina*, but in all cases except that of cetyl bromoacetate, knockdown was faster with the susceptible than with the resistant strain. This may have been because preferential toxicity, due to liberation of the bromide ion, was nullified by failure of the toxicant to penetrate to the site of action in resistant flies on account of enhanced fat deposits in the tarsi and elsewhere, as has been demonstrated in extremely resistant strains, though that the cetyl ester should be exceptional in this respect is a mere conjecture.

In the second paper, an account is given of a comparative study on the speed of action as contact poisons of iodo-, bromo- and chloroacetic acids and myristyl and cetyl bromo- and chloroacetates on *M. domestica* of the highly DDT-resistant Swiss strain. The senior authors had recorded in an earlier paper that the LD50's of iodo-, bromo- and chloroacetic acid for a strain highly resistant to chlordane and appreciably resistant to DDT and its analogues and to γ BHC (lindane) were, respectively, 1·5, 1·5 and 2·5 g. per sq. m. In the present work, the action of iodo- and bromoacetic acids and the bromoacetates was found to be much more rapid than that of chloroacetic acid and the chloroacetates. For the acids, exposure was for one hour in filter-paper cylinders treated with a solution of the test substance in a 1:2 mixture of olive oil and ether. The esters were applied in acetone solution to petri dish covers, in which the flies were exposed for 30 minutes under cotton netting The LD50's of iodo-, bromo- and chloroacetic acid at 24 hours were 1·5, 1·65 and 3·25 g. per sq. m., respectively, and the ratios between the LD50's of the bromoacetates and chloroacetates were also about 1:2. Iodo- and bromoacetic acids and myristyl and cetyl bromoacetate reached approximately their final LD50 values within about two hours, whereas chloroacetic acid and myristyl and cetyl chloroacetate needed some eight hours to reach maximum effectiveness. There is a close analogy between the speed of action of the substances tested and the *in vitro* reactivity of the halogenoacetic acids with cysteine.

It is pointed out that the marked differences in toxic action noted by Ascher in the first paper between bromo- and chloroacetates were due to the limitation of the knockdown readings to a period of two hours. The present authors' data on the esters show that the differences between the LD50's of the bromo- and chloroacetates are marked within the first two hours

(ratio 1:7 to 1:9) and become smaller with time until they reach a ratio of 1:2 after 24 hours. Ascher found that the knockdown differences between iodo- and bromoacetic acids, on the one hand, and chloroacetic acid, on the other, were less evident than those between bromoacetates and chloroacetates. This can be explained by the smaller differences in speed of action between the free acids; the LD50's of iodo- and bromoacetic acid are half that of chloroacetic acid at 24 hours and a third of it at three hours. Ascher's finding that bromoacetic acid is more active than iodoacetic acid could be explained by the fact that he used very high doses (6–10 g. per sq. m.) as compared with those used by the present authors (1–4 g. per sq. m.). The work clearly shows that, to evaluate differences in toxicity, even between substances having a similar chemical nature and the same mode of action, it is important to use data that give a clear picture of knockdown against time, since there might be very marked differences in speed of action between the substances under test.

Kilpatrick (J. W.) & Schoof (H. F.). **House fly control studies in Chatham County, Georgia.**—*J. econ. Ent.* **51** (1958) no. 6 pp. 908–910, 6 refs. Menasha, Wis., 1959.

In 1957, selected chlorinated-hydrocarbon and organophosphorus compounds were evaluated in eastern Georgia as sprays for the treatment of buildings to control house-flies (*Musca domestica* L.) on dairy farms. All potential resting places for flies in and round the barns were treated, and results were estimated by weekly grill counts [*R.A.E.*, B **38** 158]; control was considered satisfactory when the counts were 20 or below and excellent when they were 10 or below. A suspension spray providing 25 mg. EPN and 200 mg. DDT per sq. ft. gave satisfactory control for 3–7 weeks, but one giving 25 mg. EPN and 62·5 mg. sugar per sq. ft. did not. A suspension of DDT at 200 mg. per sq. ft. gave satisfactory and sometimes excellent control for eight weeks. Dow ET-57 [purified O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate] gave excellent control for 8–9 weeks at 200 mg. per sq. ft. in emulsion or suspension spray and for four weeks at 100 mg. in emulsion spray on four farms and satisfactory control for four weeks at 100 mg. with 250 mg. sugar on another. With a solution of trichlorphon (Dipterex) and sugar in water at 200 and 500 mg., respectively, per sq. ft., control was excellent for ten weeks (except during one when the count was 11) at one farm but at another was satisfactory for only two weeks after a first treatment and for six after a second. An emulsion spray affording 100 mg. malathion, 100 mg. DDT and 250 mg. sugar per sq. ft. was satisfactory for only two weeks, and 25 mg. General Chemical Compound 3707 (dimethyl 1,3-di(methoxycarbonyl)-1-propen-2-yl phosphate) or Guthion with 62·5 mg. sugar in emulsion and 25 mg. γ BHC (lindane) or 200 mg. methoxy-DDT (methoxychlor) per sq. ft. in suspension failed to give control, even immediately after application.

Diazinon-impregnated cotton cords 1/8 inch in diameter [*cf.* **46** 43] and cords 3/32 inch in diameter treated with both parathion and diazinon, installed at 30 ft. cord per 100 sq. ft. floor area, provided excellent control in dairy barns throughout observation periods of 15 and 9 weeks, respectively. Parathion-impregnated cords 3/32 inch in diameter installed at the same rate gave satisfactory control after three weeks and maintained it for 9 of the remaining 12 weeks of the observation period. Cords 3/16 inch in diameter impregnated with diazinon and installed at the same rate at a heavily infested poultry ranch rapidly reduced the very high population of *M*

domestica, but two weeks were needed to bring it down to a satisfactory level, to which it was then confined for nine weeks.

The variable results obtained with the combinations of EPN and DDT may be attributed in part to differences in fly production potential and this may well account for the difference between the effects of the two treatments with trichlorphon on one of the farms. However, the contrast between the effectiveness of EPN and DDT when applied separately suggests that the effects of the combinations were due chiefly to DDT; the mortalities of flies from the barns when exposed to DDT residues on panels indicated a similar degree of resistance in all the populations.

Rodriguez jr. (J. L.) & Riehl (L. A.). **Comparisons of diazinon, dicapthon, chlorobenzilate and Kelthane for control of the chicken mite in hen houses.**—*J. econ. Ent.* **51** (1958) no. 6 p. 911, 2 refs. Menasha, Wis., 1959.

Control of *Dermanyssus gallinae* (Deg.) in hen houses having the floor at ground level and with roosts, dropping boards and box-type nests has been obtained with 4 per cent. malathion dusts applied at 1 lb. per 20 sq. ft. and with 1 and 3 per cent. sprays [*R.A.E.*, B **45** 141, 175]. As the mite is an important pest in fowl houses of this type in southern California, two organophosphorus compounds and two chlorinated hydrocarbons were tested in an attempt to develop new treatments for its control. The test houses, each containing 250–500 hens, were of frame construction with wire fencing and had litter on the floor and wooden roosts and box-type nests. Spray was applied to wet the roosts, the inner and outer surfaces of the nest boxes and the wall supporting the latter thoroughly without run-off, and was kept away from food and water troughs, hens and eggs. Hens were not allowed into nest boxes until the latter were dry. Infestations were estimated by weekly counts of the mites at six sites each on the roosts and nest boxes in each pen. The mean number per site was more than 100 before treatment and in untreated pens throughout the periods of observation. Neither of the chlorinated hydrocarbons (chlorobenzilate and Kelthane) at 0·5–2 per cent. in emulsion sprays effected any reduction in 21 days, though mites directly hit by the spray were killed. Diazinon from emulsifiable concentrate and dicapthon from a wettable powder, both applied at 0·5 per cent., reduced the numbers per site to 3 and 0·4, respectively, in one week, and thereafter control was complete. At 0·25 per cent., they kept numbers to five or less per site for 13 and 12 weeks, after which the infestation increased.

Barker (R. J.) & Edmunds jr. (L. N.). **Toxicity of DDT in oil and in acetone to adult DDT-resistant house flies.**—*J. econ. Ent.* **51** (1958) no. 6 pp. 914–915. 6 refs. Menasha, Wis., 1959.

Busvine observed that there was less difference in the tolerance to DDT shown by a susceptible and a resistant strain of house-flies (*Musca domestica* L.) when the solvent was oil than when it was acetone [*R.A.E.*, B **41** 122]. Other workers found that the mortality rate of a susceptible strain increased more rapidly with dosage when the DDT applied was in oil than when it was in acetone [**46** 49]. Extrapolation suggested a point of intersection, at high mortalities, of the log-probit lines representing the dosage-mortality curves, above which the oil solution would be the more effective. To discover the

point of intersection, flies of a moderately resistant strain reared without exposure to DDT for six generations were treated topically with DDT in oil and in acetone. The slopes of the dosage-mortality curves for oil solutions were again steeper than those for acetone ones. Above dosages of 5·4 μg. for males and 7·7 μg. for females, the oil solution was the more effective, whereas the reverse was true at lower dosages. The results emphasise that a single dosage is unsatisfactory in assaying relative potency or synergism.

Sweatman (G. K.). **On the population reduction of chorioptic mange mites on cattle in summer.**—*Canad. J. Zool.* **36** no. 3 pp. 391–397, 7 refs. Ottawa, 1958.

Infestation by *Chorioptes bovis* (Hering) on cattle and the dermatitis caused by it both decrease considerably or virtually disappear during the summer when the cattle are at pasture [*cf. R.A.E.*, B **33** 100], and the factors responsible for the reduction were investigated in Quebec during the summer of 1956, in part on cattle that were kept indoors to maintain large infestations. The author concludes from the results obtained that extrinsic factors, of which rain, water, high skin temperatures of the host and relative humidity were investigated, appear to be of significance in reducing mite numbers, and that intraspecific factors and the change in environment in itself may also limit them. Moulting, normal desquamation, rubbing, licking and any physiological changes that may take place in the skin of the host or its secretions, hair or epidermic débris are not harmful.

Lewis (F. B.). **Abundance and seasonal distribution of the common species of Ceratopogonidae (Diptera) occurring in the State of Connecticut.**—*Canad. Ent.* **91** no. 1 pp. 15–28, 15 graphs, 8 refs. Ottawa, 1959.

Results are given of a study in which modified New Jersey light-traps, operating from sunset until midnight, were used to sample populations of Ceratopogonids in two habitats in Connecticut. Trapping was carried out weekly from 4th May to 15th September 1953 and from 4th May to 15th August 1954 in a fresh-water bog in Storrs and continuously from 24th June to 15th September 1953 and from 1st May to 15th July 1954 in a salt marsh area in Madison. It was found that a day or two of rainfall combined with a rise in temperature was almost always followed by an increase in numbers of midges. From the results, which are discussed in detail, a list is given of the 82 species in 16 genera now known from this State. *Culicoides* and *Forcipomyia* accounted for 75·7 and 20·27 per cent. of the catch in Storrs and *Atrichopogon* and *Culicoides* for 70·4 and 22·3 per cent. in Madison. These genera were represented throughout the collecting seasons. Three of the 15 species of *Culicoides* taken were restricted to the bog habitat and five to the salt-marsh. Of the other seven, only *C. biguttatus* (Coq.) appeared to develop with equal facility in both. It comprised 58·8 per cent. of the *Culicoides* catch in Storrs and 39 per cent. in Madison, and occurred from late May to early August with a small peak in early June and a main one at the end of June in the former area and from late June to early September with a main peak in early August and subsidiary ones in late July and early September in the latter. No morphological differences were found between the populations in the two areas, in spite of the different times of occurrence. The interpretation of the curves in terms of generations is discussed. The

other abundant species in Storrs was *C. piliferus* Root & Hoffman, which prefers avian to human blood and had not previously been recorded from Connecticut. *C. obsoletus* (Mg.) comprised 7·3 per cent. of the population in Storrs and was not represented in Madison. It had two population peaks in the spring (May and June), probably representing two broods of one generation, and a third small peak in autumn, representing a second generation [*cf. R.A.E.*, B **38** 49]. There was a colour difference between the spring and autumn populations. This species is responsible for much of the biting by Ceratopogonids in the north-eastern United States, and its comparative scarcity in this study is unexplained. *C. melleus* (Coq.) represented 26·9 per cent. of *Culicoides* in Madison and was plentiful from the third week in June to September with a main peak in early July and a smaller one in August. *C. furens* (Poey) had only one generation in Madison where it was third in abundance (13·7 per cent.) and had the greatest span of adult occurrence of any species taken during 1953.

Fredeen (F. J. H.). **Rearing black flies in the laboratory (Diptera: Simuliidae).**—*Canad. Ent.* **91** no. 2 pp. 73–83, 9 figs., 13 refs. Ottawa, 1959.

The following is substantially the author's summary. Methods and equipment are described by which adults of eight species of Simuliids from western Canada were reared from eggs or first-instar larvae in the laboratory. Compressed air, a platform shaker and rotating platforms were used to circulate water in aquaria at speeds characteristic of the natural habitats of the species investigated. The maximum speeds were 0·3, 1·4 and 4·5 ft. per second, respectively. The principal food used was dehydrated baker's yeast. Larvae of *Simulium venustum* Say and *S. vittatum* Zett. developed from the first instar to adults in a relatively wide range of laboratory environments, although greatest survival and growth of *S. venustum* occurred in water circulated by compressed air and *S. vittatum* was reared most successfully in aquaria on the platform shaker. Larvae of *S. arcticum* Mall. developed to maturity only in rapidly flowing water in aquaria on rotating platforms. Few eggs or larvae of *Cnephia dacotensis* (D. & S.), *S. aureum* Fries, *S. decorum* Wlk., *S. luggeri* Nicholson & Mickel and *S. meridionale* Ril. were available, but small numbers of each species were reared to the adult stage. The differences in the rates of survival and growth of larvae may have been due mainly to difference in water velocities. However, other factors such as density of the larvae, the amount and kind of food offered, temperature, and water source appeared important. Definite conclusions concerning the importance of these various factors could not be reached because of the lack of temperature control. A continuous colony of Simuliids was not established. However, the methods and equipment described should have considerable value in studies on life-cycles, behaviour and control and for associating the adult and immature stages.

Morgan (H. V.). **Onchocerciasis in the northern Sudan.**—*J. trop. Med. Hyg.* **61** no. 6 pp. 145–147, 11 refs. London, 1958.

Although *Simulium damnosum* Theo. is known to have been present at Abu Hamed in the northern Sudan for well over a century, no cases of onchocercosis (caused by *Onchocerca volvulus*) have been reported from the

area [*cf. R.A.E.*, B **41** 39]. However, in a survey in December 1956, 30 of 73 schoolboys examined and 35 of 70 residents of the district showed clinical evidence of infection. Microfilariae were found in skin samples of nine of the latter. Samples were not taken from the boys. Microfilariae were sometimes found in the gut of adults of *S. damnosum* taken biting the patients. This discovery of onchocercosis at Abu Hamed in individuals who had never visited other parts of the Sudan shows that a focus of the disease exists nearly 1,000 miles from the nearest recognised endemic area and in territory quite different in character from that usually associated with the disease. The Nile here flows through hot, dry, barren desert with only a narrow fringe of cultivation along its banks, and *S. damnosum* is found in numbers only between October and March with its highest incidence in the cold months of December and January.

Chamberlain (R. W.) & Sudia (W. D.). **The North American arthropod-borne encephalitis viruses in *Culex tarsalis* Coquillett.**—*Amer. J. Hyg.* **66** no. 2 pp. 151–159, 14 refs. Baltimore, Md., 1957.

Culex tarsalis Coq. is known to be easily infected with the virus of western equine encephalitis (WEE) and responsible for most of its transmission in the western United States and there is also evidence that it is an important vector of St. Louis encephalitis (SLE) there [*R.A.E.*, B **41** 127, etc.], but evidence of its ability to transmit eastern equine encephalitis (EEE) has been lacking. The present study was undertaken to compare the infection rates, transmission rates, thresholds of infection and extrinsic incubation periods of the three viruses in this mosquito. Studies on WEE and EEE were carried out from May to December 1954 and the SLE studies in 1955. The strains of WEE [*cf.* **44** 136] and EEE virus used were both isolated from *Culiseta melanura* (Coq.) in Louisiana and the SLE virus from *Culex tarsalis* in California. Virus titrations were made by the intracerebral inoculation of mice three weeks old or subcutaneous inoculation of chicks 12 hours old. To determine infection and transmission rates, virgin females of *C. tarsalis* 3–10 days old were allowed to feed on chicks with a high level of infection, incubated for various periods and allowed to feed again individually on fresh chicks. Criterion of transmission was the death of the chick followed by injection of its brain tissue into mice in the case of EEE and WEE and the presence of circulating virus, detected by inoculation of mice with chick heart blood 60 hours after the mosquito had fed, in that of SLE. Infection thresholds were determined by allowing the mosquitos to feed on pigeons or red-winged blackbirds (*Agelaius phoeniceus*) at times when their viraemias were low and testing the mosquitos individually for virus after incubation.

C. tarsalis was found to have exceptionally low infection thresholds [**44** 38] for all three viruses. These were about 10 mouse-intracerebral LD50's or $10^{2.7}$ chick-subcutaneous LD50's for WEE [*cf.* **46** 11], and about $10^{2.5}$ LD50's for EEE and about 1 LD50 for SLE measured in mice. The EEE threshold was similar to that previously found for *Aëdes sollicitans* (Wlk.), a mosquito suspected of being an important vector of this virus [*cf.* **44** 40]. Infection rates and transmission rates from chick to chick were very high, ranging up to 98 and 86 per cent., respectively, for WEE virus, to 96 and 95 per cent. for SLE virus and to 100 and 70 per cent. for EEE virus. In *C. tarsalis*, multiplication of WEE virus up to 16,000-fold occurred, and multiplication of SLE virus up to ten-million-fold has been recorded [**45** 103]. Attempts to find evidence of transovarian transmission

for all three viruses gave negative results [*cf.* **46** 11–12; **47** 178] but were inconclusive as most of the eggs used were infertile. Transmission of WEE and EEE viruses from pigeon to pigeon was accomplished. Extrinsic incubation periods for WEE and EEE viruses at 80°F. were longer than those reported for *A. aegypti* (L.) [**44** 39], but this does not imply lower vector efficiency provided the mosquito is long-lived and cold weather does not intervene.

These studies show *C. tarsalis* to be highly susceptible to all three viruses. The absence of EEE from the western part of the United States in spite of the demonstrated high vector potential of *C. tarsalis* for the virus emphasises that the natural ecology of the disease is complicated by factors other than the ability of a mosquito to become infected and to transmit.

Williams (R. W.). **A study of the summer filth fly population of the Bermuda Islands.**—*J. Parasit.* **44** no. 3 pp. 339–342, 10 refs. Lancaster, Pa., 1958.

Studies made during 1955 on certain biting flies in the Bermuda Islands [*R.A.E.*, B **45** 85] were followed by studies of the filth flies (flies attracted to decomposing organic matter for feeding or for depositing their eggs or larvae) that occur there. Nearly 9,240, of 12 species, were collected in two traps baited with decomposing fish and exposed from 1st June to 23rd August 1957, one in the town of St. George and the other in a farming area. The total catches in the two traps were not significantly different, and the species taken in them were the same, though some were more numerous in the urban and others in the rural area. The most plentiful species was *Callitroga macellaria* (F.), which formed 70·5 per cent. of the total catch in the town and 43·8 per cent. at the farm; the other comparatively plentiful ones included *Musca domestica* L., *Sarcophaga ventricosa* Wulp and *Lucilia* (*Phaenicia*) *sericata* (Mg.), which formed 11, 4·1 and 3·8 per cent., respectively, of the catch in the town and 7·1, 27·8 and 1 per cent. at the farm. Seven species, including *C. macellaria* and *S. ventricosa*, are recorded from Bermuda for the first time. *M. domestica* seemed to be more attracted to fish in Bermuda than it had been in parts of the United States in which similar studies were made. Of some 1,325 flies reared from the bait, 83 per cent. were *C. macellaria* and the remainder *L. sericata*. The over-all population of filth flies in the Bermuda Islands is low, and this is attributed mainly to the frequent periods of high winds and driving rains.

Papers noticed by Title only.

Tokunaga (M.) & Murachi (E. K.). **Insects of Micronesia. Vol. 12 no. 3. Diptera: Ceratopogonidae.**—pp. [3 +] 103–434, 98 figs., 1 map, 31 refs. Honolulu, Bishop Mus., 1959. Quate (L. W.). **Vol. 12 no. 4. Diptera: Psychodidae.**—pp. [3 +] 435–484, 25 figs., 1 map. 1959. [*Cf. R.A.E.*, B **45** 87; **47** 96.]

Tarpley (W. A.). **Studies on the use of the brine shrimp** *Artemia salina* **(Leach) as a test organism for bioassay.**—*J. econ. Ent.* **51** (1958) no. 6 pp. 780–783, 1 graph, 9 refs. Menasha, Wis., 1959. [*Cf. R.A.E.*, A **48** 116.]

Provost (M. W.). **The dispersal of *Aedes taeniorhynchus*. II. The second experiment.**—*Mosq. News* **17** no. 4 pp. 233–247, 3 figs., 8 refs. Albany, N.Y., 1957.

An experiment on the dispersal of *Aëdes taeniorhynchus* (Wied.) was carried out in south-western Florida in June and July 1952. To provide the two million early fourth-instar larvae required for marking, some 1,500 sq. ft. of sod from a swale, the soil of which was known to contain 1,000–2,000 eggs per sq. ft., was cut and transported to a specially isolated and drained pool in a clean, deep borrow-pit, and water was pumped into the pool on the same day. Some hatching occurred from seepage water on the bottom during the period of sod-laying, but about 94–95 per cent. of the eggs hatched within the 2-hour period of flooding and one hour after it, yielding about 2,250,000 larvae. When most of the larvae had been in the fourth instar for 16–24 hours, they were transferred to wooden vats containing water from the pool, and radioactive phosphorus (^{32}P) was added to two of the vats, each containing 600,000 larvae, to give a dosage of 0·077 and to a third, containing 700,000 larvae, to give 0·065 μc. per ml. (0·022 and 0·016 μc. per larva). The larvae fed for 13 hours, and the radioactivity of the resulting males and females averaged 500 and 2,000 counts per minute, respectively. One and a half million mosquitos so marked, all of which had emerged within eight hours on one afternoon, were allowed to disperse from an island in San Carlos Bay; throughout the next month collections were made systematically, up to a distance of 59 miles from the point of release, in traps of various sorts, and the mosquitos caught were examined for radioactivity.

The following is based on the author's summary of the findings. The main dispersal occurred in the middle of the night [*cf. R.A.E.*, B **46** 123]. Females were recovered up to 25 miles away and until the 24th night after emergence. Only a few males were recovered, all within three miles. The dispersal was generally down-wind. Findings support the hypotheses that migration (movement that is an end in itself) occurs on the night of departure only, so that departures at twilight will result in longer migrations than departures in the middle of the night, appetential flights (those made in search of food, shelter, oviposition sites, etc.) expand the range of occupation by a brood much beyond that established by the migration, and appetential flights are not undertaken across any large expanse of water.

McWilliams (J. G.) & Munn (B. L.). **Studies of mosquito resistance to insecticides at some naval activities.**—*Mosq. News* **17** no. 4 pp. 258–260, 2 refs. Albany, N.Y., 1957.

In 1955, preliminary tests were carried out on fourth-instar larvae of *Culex pipiens fatigans* Wied. (*quinquefasciatus*, auct.) from four localities in Porto Rico, where resistance to DDT had been reported. The corrected percentage mortalities in 48 hours given by 0·01 and (in brackets) 0·025 part DDT per million (in acetone suspensions), which caused 62–100 (86–100) per cent. mortality of a standard non-resistant laboratory strain, were 11·1 (17·9), 16 (16), 17·9 (36·5) and 58·5 (48·2), respectively. Similar tests were made with larvae of salt-marsh mosquitos (*Aëdes sollicitans* (Wlk.) and *A. taeniorhynchus* (Wied.)) collected in September 1956 in and near Key West, Florida, where DDT, BHC and dieldrin had been used for several years. The corrected 48-hour mortality given by 0·01–0·1 p.p.m. DDT, 0·005–0·025 p.p.m. γ BHC (lindane) and 0·005–0·025 p.p.m. dieldrin (all in acetone suspensions) was never over 42 per cent., whereas, except in one instance, mortality of the non-resistant strain ranged from 51 to 100

per cent. Both sets of results were highly indicative of resistance in the populations tested.

Davis (A. N.), Gahan (J. B.), Fluno (J. A.) & Anthony (D. W.). **Larvicide tests against blackflies in slow-moving streams.**—*Mosq. News* **17** no. 4 pp. 261–265, 5 refs. Albany, N.Y., 1957.

Field investigations were carried out in 1954–56 to evaluate DDT, dieldrin and parathion for the control of larvae of *Simulium* spp. in slow-flowing streams in Florida and South Carolina, where two of the species are frequently serious pests of turkeys [*cf. R.A.E.*, B **45** 42]. Preliminary tests in 1954 in South Carolina with DDT showed that emulsion concentrates applied from a dripping apparatus and an oil solution applied with a hand sprayer, both at 0·1 part toxicant per million, and bentonite granules impregnated with 5 per cent. DDT and used at 1 lb. per acre were all effective, at least for short distances. Further tests of automatic application were made in 1956. In Florida, emulsifiable preparations of parathion applied automatically at 0·5 and 1 p.p.m. toxicant eliminated all larvae at points 1·6 and 0·6 miles, respectively, downstream with treatment periods of five minutes, but failed to give good control 2·3 miles downstream with treatment maintained for 5–24 minutes. In South Carolina, similar applications lasting 10 and 20 minutes eliminated all larvae up to 2·8 miles. One 20-minute treatment caused complete control for 1·25 miles but none after 2·5 miles. The greatest distances at which DDT was effective in either State were 0·27–0·28 mile. In tests in South Carolina in 1955, plots 11 and 4 sq. miles in area were sprayed with a solution of 5 per cent. DDT in fuel oil to give 0·2 lb. toxicant per acre. Treatment resulted in at least 99 and 95 per cent. control, respectively, for two weeks, although much of the material fell on dry land; it then gradually lost effectiveness. Aerial applications of dieldrin-impregnated attapulgite granules to a plot of 1 sq. mile at 0·04 lb. dieldrin per acre eliminated larvae for two weeks, and maintained control at considerably more than 90 per cent. for four weeks.

Bidlingmayer (W. L.). **Studies on *Culicoides furens* (Poey) at Vero Beach.**—*Mosq. News* **17** no. 4 pp. 292–294, 2 refs. Albany, N.Y., 1957.

In studies of the habitats of *Culicoides furens* (Poey) in Florida, larvae were separated from soil by three methods. In the first, a sample of soil was flooded, mixed and allowed to resettle overnight, the top 1·5 in. was sieved through a coarse screen and then through a 100-mesh screen, and the material remaining on the latter was immersed in a saturated solution of magnesium sulphate, in which most of the larvae float [*cf. R.A.E.*, A **32** 306–307]. All the larvae seen were collected, and the sample was restirred and examined until three consecutive examinations were negative. In the second method, fuller's earth that had been mixed to a soft consistency with water was poured on to the soil sample to form a layer 1·5 in. thick and the whole was flooded; the fuller's earth was removed on the following day and washed through a 140-mesh screen and the residue washed into a black photographic developing tray; the pale larvae, which could easily be seen against the dark background, were then collected. In the third method, the layer of fuller's earth was replaced by a 2-inch layer of sand and this, after being removed on the following day, was washed and the wash-water poured through a 140-mesh sieve and the residue treated as in the second method. The three methods resulted in recovery of averages of 74, 70 and 67 per cent. of known numbers of larvae, respectively, but the first took about twice as long as the other two. Sand was preferred to fuller's earth, as preliminary mixing with water was not necessary. In

examination of field samples collected from a salt-marsh locality in eastern Florida over a period of one year, more than ten times as many larvae were found in samples taken along the edges of ditches and ponds as in those taken on transects across the surface of marshland. Larvae disappeared from the transects when the marsh dried, but sometimes reappeared when it was reflooded. Some were found at depths as great as 24 in., but crab-holes may have provided the means of descent. The greatest numbers were found along the larger drainage ditches, in which the water level fluctuates with the tide. Clay soils were not favoured, probably because of their compactness, but peat and sand and mixtures of them were used about equally. The larvae were observed to pupate above the water line; if pupae were flooded, they were able to float to the surface, so that emergence is not affected if flooding occurs after pupation has been completed. No pupation occurred when the larvae were prevented from leaving the water.

McFarland (G. C.). **Results of field trials with DDVP in mosquito control.** —*Mosq. News* **17** no. 4 pp. 296–298, 3 refs. Albany, N.Y., 1957.

Tests were made in California in 1956 with a 24·6 per cent. emulsifiable concentrate of dichlorvos (DDVP) for the control of mosquito larvae in three highly polluted pools with a surface area of about 3,500 sq. ft. each. About 75–80 per cent. of the larvae were *Culex stigmatosoma* Dyar, and the remainder were *C. pipiens* L. The concentrate was applied at the rate of 1, 2 or 4 oz. toxicant per acre in 10–15 U.S. gal. water. The two higher concentrations gave complete kill of larvae and pupae within six hours, and the weakest killed 85–90 per cent. within six hours but did not give complete kill in 24 hours. The fact that no larvae developed from eggs collected after treatment indicated that all concentrations were either ovicidal or killed the hatching larvae. The appearance of first-instar larvae in all pools two days after treatment indicated that toxicity was of short duration.

Newson (H. D.) & Blakeslee (T. E.). **Observations of a laboratory colony of the mosquito** *Culex tritaeniorhynchus* **Giles.**—*Mosq. News* **17** no. 4 pp. 308–311, 3 refs. Albany, N.Y., 1957.

The stock colony of *Culex tritaeniorhynchus* Giles established in a large cage in Japan [*R.A.E.*, B **46** 196–197] is reported to have reached the estimated twelfth generation. There was a slight increase in the viability of the egg-rafts currently produced, 97 per cent. of which contained viable eggs; a group of over 200 egg-rafts, selected at random, contained 97–427 eggs each, with an average of 214, and 90 per cent. of the eggs were viable. Males have lived up to 29 and females up to 107 days at 75°F. and a relative humidity of 80–95 per cent. One female produced a viable egg-raft when 102 days old and after having been isolated from males for 78 days, and took a blood-meal on rabbit on the following night. These results suggest that females can live long enough to overwinter in Japan and take blood-meals and produce viable egg-rafts in the spring [*cf.* **46** 158]. Some females were inseminated and took their first blood-meal as early as 56 hours after emergence and produced viable egg-rafts four days later, but most mate and take their first blood-meal 7 or 8 days after emergence. Some mate before taking a blood-meal and some after it, and some mate several times. A limited study by I. Gresser and others indicated that females in the colony had retained their ability to transmit the virus of Japanese B encephalitis among laboratory animals [*cf.* **40** 163]. Changes

noted in adult and larval behaviour during the adaptation of the colony to laboratory conditions are indicated. They include an acquired readiness on the part of the females to feed on man, and greater readiness of both sexes to swarm in the cage. Daily exposure to light for about 15 hours has been found to be necessary to maintain a satisfactory level of adult activity; when this was reduced to 13 hours there was a trend towards hibernation with a steady decrease in feeding, mating activity and egg-production, and an increase in fat-body. A self-sustaining subcolony was established from the estimated fifth and sixth generations in a cage measuring 3 × 3 × 3 ft., with essentially the same rearing technique and lighting schedule as were used for the stock colony.

Steinhaus (E. A.) & Smith (R. F.). Ed. **Annual review of entomology. Volume 5.**—9 × 6 in., viii + 451 pp., illus., many refs. Palo Alto, Cal., Annual Reviews, Inc., 1960.

The reviews in this fifth volume of a series [*cf. R.A.E.*, B **45** 27; **47** 61], all of which are noticed elsewhere [A **48** 184], include: **Northern biting flies,** by B. Hocking (pp. 135–152, 290 refs.), who discusses the morphology, physiology, behaviour, bionomics, ecology, importance and control of the Ceratopogonids, mosquitos, Simuliids and Tabanids that inhabit the tundra and boreal forest where snow lies regularly throughout the winter in northern regions of the world, principally Alaska, Canada and the Soviet Union, and take human blood; **Mechanisms of resistance against insecticides,** by A. W. A. Brown (pp. 301–326, 221 refs.), in which the insecticides considered include DDT, dieldrin, BHC, various organophosphorus compounds, pyrethrins and arsenicals, and a note on negatively correlated cross-resistance is included; **Pesticides in relation to public health,** by W. J. Hayes jr. (pp. 379–404, 5 graphs, 107 refs.), who reviews the benefits to health resulting directly from the use of chemicals for the control of arthropod vectors of diseases of man and indirectly from their use against insect pests of plants, through increased production of foodstuffs and other materials, the hazards to health involved in their production and application, methods of minimising such hazards, and the diagnosis and treatment of accidental poisoning; and **Biological relationships between lice (Anoplura) and microbial agents,** by F. Weyer (pp. 405–420, 96 refs.), in which the principal louse considered is *Pediculus humanus humanus* L. and the disease agents include viruses, bacteria, rickettsiae and spirochaetes.

In addition to the usual index to the authors whose work is reviewed and one to the subjects discussed, cumulative indexes to the reviews, classified under broad headings, and to the contributing authors for all five volumes so far published are included.

Cysin (H.) & Margot (A.). **Chemistry and toxicological properties of O,O-diethyl-O-(2-isopropyl-4-methyl-6-pyrimidinyl) phosphorothioate (diazinon).**—*J. agric. Fd Chem.* **6** no. 12 pp. 900–903, 1 graph, 12 refs. Easton, Pa., 1958.

The following is substantially the authors' summary. Diazinon (O,O-diethyl O-2-isopropyl-4-methyl-6-pyrimidinyl) phosphorothioate is prepared by condensation of 2-isopropyl-4-methyl-6-hydroxypyrimidine with O,O-diethyl phosphorochloridothioate. The presence in the latter of small amounts of O-ethyl phosphorodichloridothioate and triethyl phosphorothioate results in technical diazinon, which contains as impurities triethyl phosphorothioate and O-ethyl O,O-di(2-isopropyl-4-methyl-6-pyrimidinyl) phosphorothioate. Diazinon is obtained in a pure state by distillation or through

formation of a mineral acid salt. Pure diazinon is not a potent cholinesterase inhibitor, but on distillation or long standing increased anticholinesterase activity is found. Various possible isomerisation and decomposition products were prepared, but the compound responsible for the increased activity was not found.

Wiley (A. J.). **Distribution of the common brown tick in Kenya.**—*E. Afr. agric. J.* **24** no. 1 pp. 53–56, 1 map, 9 refs. Nairobi, 1958.

Knowledge on *Rhipicephalus appendiculatus* Neum. as a vector of East Coast fever of cattle in East Africa is reviewed historically, and the distribution of the tick in the various provinces of Kenya is discussed. An annual rainfall of at least 20–25 in. is necessary for the survival of the tick, which occurs throughout western Kenya and is common in the highlands below about 7,500 ft., especially where cultivation predominates and where dipping is not carried out; it is also distributed sporadically in the southern part of the coastal belt but is usually absent from the high plateau, the plains, the deserts and the dry bush areas. Low temperatures probably account for its absence above 7,500 ft.

Smithburn (K. C.) & De Meillon (B.). **Studies on arthropod-borne viruses of Tongaland. I. The expedition of April–May, 1955.**—*S. Afr. J. med. Sci.* **22** pp. 41–46, 1 map, 3 refs. Johannesburg, 1957.

De Meillon (B.), Paterson (H. E.) & Muspratt (J.). **II. Notes on the more common mosquitoes.**—*T. c.* pp. 47–53, 12 refs.

Davis (D. H. S.). **III. The small wild mammals in relation to the virus studies.**—*T. c.* pp. 55–61, 10 refs.

Paterson (H. E.), Kokernot (R. H.) & Davis (D. H. S.). **IV. The birds of Tongaland and their possible role in virus disease.**—*T. c.* pp. 63–69, 14 refs.

Kokernot (R. H.), Heymann (C. S.), Muspratt (J.) & Wolstenholme (B.). **V. Isolation of Bunyamwera and Rift Valley fever viruses from mosquitoes.**—*T. c.* pp. 71–80, 1 pl., 7 refs.

Kokernot (R. H.), Smithburn (K. C.), Weinbren (M. P.) & De Meillon (B.). **VI. Isolation of Pongola virus from** *Aedes* (*Banksinella*) *circumluteolus* **Theo.**—*T. c.* pp. 81–92, 6 refs.

Weinbren (M. P.), Heymann (C. S.), Kokernot (R. H.) & Paterson (H. E.). **VII. Simbu virus, a hitherto unknown agent isolated from** *Aedes* (*Banksinella*) *circumluteolus* **Theo.**—*T. c.* pp. 93–102, 5 refs.

Kokernot (R. H.), Smithburn (K. C.), Muspratt (J.) & Hodgson (B.). **VIII. Spondweni virus, an agent previously unknown, isolated from** *Taeniorhynchus* (*Mansonioides*) *uniformis* **Theo.**—*T. c.* pp. 103–112, 2 pls., 1 graph, 9 refs.

Smithburn (K. C.), Kokernot (R. H.), Weinbren (M. P.) & De Meillon (B.). **IX. Isolation of Wesselsbron virus from a naturally infected human being and from** *Aedes* (*Banksinella*) *circumluteolus* **Theo.**—*T. c.* pp. 113–120, 6 refs.

Muspratt (J.), Smithburn (K. C.), Paterson (H. E.) & Kokernot (R. H.). **X. The laboratory transmission of Wesselsbron virus by the bite of** *Aedes* (*Banksinella*) *circumluteolus* **Theo.**—*T. c.* pp. 121–126, 3 refs.

The first of these papers forms an introduction to the later ones, in which discoveries made during or as a result of a virological expedition to the Ubombo and Ingwavuma districts (Tongaland) of northern Natal in April and May 1955. Systematic surveys for antibodies to certain arthropod-borne

viruses in the sera of people living in various parts of South Africa, undertaken early in 1954, had shown a higher incidence of humoral immunity from several viruses among inhabitants of the Lake Simbu region of Tongaland than in any of the other areas surveyed, which included localities in the eastern Cape Province, northern and eastern Transvaal and northern Natal. The topography and climate of Tongaland are described and the objectives and organisation of the expedition explained.

The following paragraphs are mostly based on the authors' summaries of the nine subsequent papers.

The techniques used in the capture and biological study of mosquitos at Lake Simbu are described in the second paper, and a list is given of the species collected, together with information on the bionomics of two from which virus was isolated and brief notes on those of the other commoner ones. *Aëdes circumluteolus* (Theo.), from which 15 strains were isolated, was the commonest mosquito in the region and probably the main vector. It does not enter dwellings, and was not caught on the lake or on its shores, but large numbers were taken on vegetation in tracts of bush and scrub. The females bit man, ox, goat and dog, but not birds, and few came to stationary human bait, though small numbers came to bite at all hours. Feeding was confined to ground level, and no females were caught on a tree platform 30 ft. high. Immature stages were found in shallow temporary pools, and the species overwintered mainly in the form of drought-resistant eggs. In suitable years, large populations of adults develop suddenly and rapidly. It is concluded that the species is excellently suited to serve as a vector in short and explosive outbreaks of virus infections. *Mansonia* (*Taeniorhynchus*) *uniformis* (Theo.), from which Spondweni virus was isolated [*cf.* the eighth paper], was less common. It enters dwellings and probably feeds on most warm-blooded animals; it was taken biting on the 30-ft. platform. The winter is passed in the adult stage, and breeding is probably continuous. It may maintain virus in months in which important vectors are absent. *Culex poicilipes* (Theo.) was by far the commonest man-biter in the evening on the exposed lake, its shore and the platform. It was not found away from the lake in scrub and thick bush.

An account of a study of 15 species of small mammals from the Lake Simbu area and results of immunological tests on blood specimens from ten of them are given in the third paper. Neutralisation tests were made with four viruses isolated in Tongaland, and the results were negative, but this was inconclusive because of the small numbers involved.

Observations on the birds of Tongaland are recorded in the fourth, and brief descriptions are given of their habitats, together with the results of serological tests of a limited sample against five viruses (Pongola, Bunyamwera, Wesselsbron, Bwamba fever and Rift Valley fever); neutralising antibodies for one or other of the first four were found in six species and for three of them in the dwarf goose (*Nettapus auritus*). Six of the seven positive species were water birds and the seventh semi-aquatic. The dwarf goose nests in holes in trees. As there is no evidence that birds are bitten by *A. circumluteolus*, and since those living in habitats that would favour attack by this mosquito had no neutralising antibodies, some species of mosquito other than *A. circumluteolus* is likely to be responsible for transmission among them. *C. poicilipes*, which is known to bite birds, was abundant, and *M. uniformis* (from which a virus was isolated) was present, in the habitats of the birds that showed antibodies.

The isolation of Bunyamwera virus [*cf. R.A.E.*, B **37** 150] from a batch of 290 females of *A. circumluteolus* caught near Lake Simbu in April, of the virus of Rift Valley fever from a batch of 195 females of the same species caught in the same area in May and of what appeared to be a

mixture of the two viruses from a pool of 300 females also of *A. circumluteolus* caught near the lake in April is recorded in the fifth paper.

An account is given in the sixth of the isolation from a pool of 75 females of *A. circumluteolus* caught in April near Lake Simbu of a virus shown by cross-neutralisation tests with monkey immune sera and local human, donkey, goat and bird sera to be related to the virus of Bwamba fever [42 165], but not identical with it. It is designated Pongola virus, as the Pongola river flows through the region in which the mosquitos were collected. Nine other strains of virus isolated from *A. circumluteolus* are, on the basis of limited serological study, thought also to be strains of Pongola virus. Data are given on the characteristics of the agent, which is pathogenic for adult white Swiss mice by intracerebral but not by intraperitoneal inoculation and produces a neutralising antibody but no clinical symptoms when inoculated into monkeys and guineapigs. Intracerebral inoculation into Swiss mice produced brain lesions compatible with encephalitis. Protection tests indicated that Pongola virus has a wide host range in Tongaland with a significant incidence in man.

An account is given in the seventh paper of the isolation of a filterable virus from a batch of 293 females of *A. circumluteolus* caught near Lake Simbu on 26th April, and experiments are reported indicating that it represents a hitherto undescribed entity, here named Simbu virus, apparently related antigenically to Bunyamwera virus but not identical with it. Simbu virus is pathogenic for suckling or adult mice by intracerebral inoculation and for new-born mice by intraperitoneal inoculation also, causing lesions in the brain only and it evokes a neutralising-antibody response but does not cause manifest illness in rabbits, guineapigs or vervet monkeys (*Cercopithecus aethiops pygerythrus*).

It is recorded in the eighth that a virus, believed to be hitherto undescribed, was isolated from a pool of 49 females of *M. uniformis* caught in May biting man or resting on vegetation in the small native district of Spondweni near Lake Simbu. The name Spondweni virus is assigned to it. It is pathogenic for adult white Swiss mice when inoculated intracerebrally, though there was no viraemic phase in them, and it produces a neutralising-antibody response but no clinical symptoms in vervet monkey, guineapigs and rabbits. It produced no antibody response in chicks. Antibodies neutralising Spondweni virus were detected in the sera of a few people over 32 years of age living at Mabandhleni, in the lowlands on the Mkuzi river.

The isolation of two strains of virus is recorded in the ninth paper, one in April from the blood of an African member of the expedition who normally lived some way from Lake Simbu and was suffering from febrile illness, and the other from females of *A. circumluteolus* taken near the lake in May. The results of immunological and serological tests showed that the two strains were identical with each other and with a virus isolated from a lamb in Wesselsbron, Orange Free State, in March 1955 and designated Wesselsbron virus. The agent is pathogenic for suckling and adult mice on intracerebral inoculation. Vervet monkeys exhibited good antibody response but were not highly susceptible, and guineapigs developed good antibody response but no clinical symptoms. A European member of the expedition, who suffered a mild febrile illness, was later shown to have antibodies to Wesselsbron virus in his blood, whereas a pre-expedition sample of his serum was devoid of them. Immunity surveys among residents in various parts of Tongaland showed a high percentage of donors to have protective sera. The prototype strain was reported to have caused four manifest cases of illness and one sub-clinical infection among laboratory workers. It had an apparent affinity for embryonic tissue in sheep and caused abortion in them. Sheep, cattle, horses and pigs inoculated experimentally showed febrile

reactions, without mortality, and developed neutralising antibodies. Immunity from the virus has been found among sheep in the Orange Free State and Nyasaland and among cattle in Cape Province, Transvaal and the Rhodesias. In Tongaland, a high incidence of immunity was found in cattle, sheep, goats, dogs and donkeys, and in several species of wild birds.

An account is given in the last paper of an experiment on the ability of *A. circumluteolus* to harbour and transmit Wesselsbron virus in the laboratory, with descriptions of the techniques used. The mosquitos were fed on a suspension of infected mouse brain and heparinised rabbit blood with sugar on cotton-wool. Virus was detected in two females 71 days after the infective feed by inoculation into mice, and was transmitted by bite to suckling mice on several occasions 11–67 days after the infective feed. This is the first demonstration that a species of the subgenus *Neomelaniconion* (*Banksinella*) of *Aëdes* can transmit a virus [*cf.* also next abstract.]

Kokernot (R. H.), De Meillon (B.), Paterson (H. E.), Heymann (C. S.) & Smithburn (K. C.). **Middelburg virus, a hitherto unknown agent isolated from *Aedes* mosquitoes during an epizootic in sheep in the eastern Cape Province.**—*S. Afr. J. med. Sci.* **22** pp. 145–153, 13 refs. Johannesburg, 1957.

In April 1957, Wesselsbron virus [see preceding abstract] was isolated from sheep, man and two species of mosquitos from the Middelburg district of eastern Cape Province, where there had been an outbreak of illness among sheep, and strains of a filterable virus, indicated by immunological studies to be a hitherto unknown agent, were also isolated from a pool of 50 females of *Aëdes* (*Ochlerotatus*) *caballus* (Theo.) and one of 51 females of two species of the subgenus *Neomelaniconion* (*Banksinella*) of *Aëdes*, *A. lineatopennis* (Ludl.) and *A. albothorax* (Theo.) or a species near it, collected in the same district. The name Middelburg virus is proposed for it. During the same studies, *A. caballus* yielded 14 other strains of virus, which behaved similarly in mice and are thought to be identical with Middelburg virus or related to it. *A. caballus* was the prevalent mosquito in the field and had an extremely high virus infection rate. The Middelburg virus is pathogenic for mice 1–5 days old by intracerebral or intraperitoneal inoculation (with an incubation period of 2–3 days) but not for adult mice. It provoked a neutralising-antibody response in chicks, guineapigs and a monkey (*Cercopithecus aethiops pygerythrus*). Further tests showed that laboratory-reared females of *A. caballus*, allowed to engorge on a mixture of blood with a suspension of mouse brain infected with Middelburg virus, transmitted the agent to lambs, suckling mice and day-old chicks after incubation periods of 4, 10 and 19 days, respectively, and that females of this mosquito acquired infection by feeding on a lamb circulating the virus, and transmitted the latter by bite to another lamb after ten days. After being inoculated with Middelburg virus or bitten by females of *A. caballus* infected with this agent, susceptible lambs developed viraemia and a high temperature, and subsequently showed a high titre of neutralising antibody and became fully resistant to challenge by the homologous virus, though remaining susceptible to Wesselsbron virus and the virus of Rift Valley fever. There were no fatalities. Neutralising antibodies were detected in the sera of two of nine people who frequented the area from which the virus had originated and in the sera of ten out of 13 convalescent ewes that were reported to have been ill during the outbreak.

Kokernot (R. H.), Paterson (H. E.) & De Meillon (B.). **Studies on the transmission of Wesselsbron virus by** *Aedes (Ochlerotatus) caballus* **(Theo.).**—*S. Afr. med. J.* **32** pp. 546–548, 5 refs. Cape Town, 1958.

In April 1957, two batches of laboratory-reared females of *Aëdes caballus* (Theo.) were allowed to engorge on a lamb from Middelburg, Cape Province, that had a temperature of over 104°F. and had Wesselsbron virus [*R.A.E.*, B **48** 71] circulating in its blood. The lamb had been bitten 2–3 days previously by mosquitos of the same species caught in an area in which an epizootic was in progress, and the presence of the virus in the mosquitos was demonstrated. Their responsibility for infecting the lamb was, however, not proved because it had come from a flock in which sickness and mortality due to the Wesselsbron virus were already occurring. The lamb died on the fifth day. On the 21st and 22nd post-engorgement days, mosquitos from the two batches transmitted the virus by biting to one out of seven and to all of seven new-born mice, respectively. In an experiment in which 134 females of *A. caballus*, caught in the epizootic area, were observed to probe or engorge on 31 new-born mice, one of the mice became ill, and the presence of Wesselsbron virus in it was confirmed.

Chow (C. Y.), Ibnoe (R. M.) & Soejoed Tarko Josopoero. **Bionomics of Anopheline mosquitos in inland areas of Java, with special reference to** *Anopheles aconitus* **Dön.**—*Bull. ent. Res.* **50** pt. 4 pp. 647–660, 5 refs. London, 1960.

The following is substantially the authors' summary. *Anopheles aconitus* Dön. has long been known as an important vector of malaria in Indonesia and has more recently been shown to be the principal vector in the inland areas of Java, while *A. maculatus* Theo. has been regarded as an important vector in hilly regions [*R.A.E.*, B **48** 46]. The observations recorded were carried out in an inland rice-growing area in East Java between June 1957 and May 1958 and in a hilly area in West Java between April 1956 and March 1957; they were concerned, in particular, with the resting and feeding habits of the two species in so far as they might influence methods of control. Neither of the observation areas had been sprayed. *A. aconitus* was found in great numbers throughout the year, with a major peak from March to May, about harvest time of the first and more extensive rice crop, and a minor peak in September and October. It is largely exophilous in the areas studied and, as regards man, exophagous. Nearly three times as many females were taken biting man outdoors as indoors, and 17 per cent. of 359 females that were taken outdoors and examined by the precipitin test showed human blood, as compared with 5 per cent. of 1,438 from all situations; of these 1,438, 93·5 per cent. contained ox blood. On the whole, therefore, this species appeared to be highly, though not exclusively, zoophilous [*cf.* **20** 168]. The females readily entered bamboo-matting cattle sheds to feed. In sheds with walls as well as roofs, up to 75 per cent. may remain for at least two hours after having fed, and appreciable but variable numbers of fully fed females may remain during the day. Most of the feeding on man outdoors took place before midnight, and most feeding on cattle in sheds between midnight and 6 a.m. with peaks between midnight and 1 a.m. and between 4 and 5 a.m. Peak periods of entry into an animal-baited trap were during the second and fourth quarters of the night. As the results of these studies differ somewhat from those previously reported for other localities in Java, the investigations should be repeated in other areas and experiments carried out on the effect of applications of a deposit insecticide on a population of *A. aconitus*.

A. maculatus occurred in the hilly area in considerable numbers throughout the year, with no great seasonal fluctuation. The adults rested mainly on coffee plants and palms both by day and by night, but readily entered cattle sheds at night. No blood-meals from this species were subjected to the precipitin test. It is suggested that the importance of *A. maculatus* in the transmission of malaria [*cf.* **30** 18] needs further investigation. Over 1,000 females of *A. aconitus* and *A. maculatus*, taken in the hilly area, were dissected, but no malaria infection was found. *A. vagus* Dön. was present in the inland area in large numbers during the greater part of the year, with a peak from November to February, during the rainy season. It is more endophilous and endophagous than *A. aconitus* but is not considered important in malaria transmission. *A. annularis* Wulp had a peak in March, but *A. kochi* Dön., *A. barbirostris* Wulp, *A. subpictus malayensis* Hack. and *A. tessellatus* Theo. were never found in more than small numbers; these species are highly zoophilous in the areas studied, and are not considered to be important vectors of malaria.

Surtees (G.). **The breeding behaviour of the type form of *Aëdes* (*Stegomyia*) *aegypti* (L.) in south-western Nigeria in relation to insecticidal control.**—*Bull. ent. Res.* **50** pt. 4 pp. 681–686, 15 refs. London, 1960.

Aëdes aegypti (L.), represented by the typical form [*R.A.E.*, B **47** 19], proved to be one of the most widespread mosquitos encountered during ecological studies in south-western Nigeria. It was found breeding in the basins of rotting tree stumps in the coastal mangrove swamp, in holes in living trees in fresh-water swamp and round Lagos, and in domestic water containers in village clearings in the inland rain-forest. It did not occur elsewhere in the forest. Its breeding behaviour was studied by quantitative surveys, carried out in a rain-forest village (Ilobi) 50 miles north-west of Lagos and in the capital itself. Baked clay pots holding half a gallon of water were placed inside houses, outside but in otherwise sheltered positions, and in situations fully exposed to the sun, and were examined weekly. There was more breeding in pots inside houses than in those outside, in both areas, but this was relatively less marked at Lagos than at Ilobi. Piped water is available in the capital, and storage pots are therefore not normally plentiful, and larvae were found there in pots contaminated with decaying vegetable matter though they were absent from such pots at Ilobi. This suggests that the mosquito is more tolerant of organic matter in Lagos, where it breeds typically in tree holes, though it has a latent or suppressed domestic behaviour pattern.

In spraying tests carried out in Ilobi in 1957, the percentage mortality of fourth-instar larvae exposed in pots to 5 per cent. DDT in oil applied from aircraft at 0·5 lb. per acre, using a rotary atomiser, was 2 in houses, 1·5 immediately outside under overhanging eaves, 83·5 in ground vegetation within the village and 50 beneath bush and tree canopy on the village edge. When 15 per cent. dieldrin in oil was applied from a Swingfog apparatus [*cf. R.A.E.*, B **44** 130] at 0·8 oz. per acre, both indoors and out, 80–100 per cent. of the larvae in the houses, and 50–80 per cent. of those in vegetation, were killed. Adults exposed in cages in houses all died, but eggs exposed in petri dishes were not affected. Control is made difficult by the comparative inaccessibility of the breeding sites, and eradication over a wide area would appear to be unattainable, owing to the plasticity of the breeding behaviour of the species. It is suggested, however, that individual treatment of breeding places with insecticide pellets [*cf.* **45** 131] before the beginning of the rainy season, would ensure a high mortality

of first-generation larvae. The toxicity hazard to man is considered not very great. Watch should be kept for the development of resistance in treated populations, by both laboratory and field observations, and on the possible establishment of wild populations in forested areas, as a result of a campaign against a domestic mosquito, either through an alteration in oviposition behaviour arising from the development of behaviouristic resistance, or by an increase in the naturally occurring tree-hole breeders to a position of dominance in the area.

McClelland (G. A. H.). **Observations on the mosquito,** *Aëdes* (*Stegomyia*) *aegypti* **(L.), in East Africa. II. The biting cycle in a domestic population on the Kenya coast.**—*Bull. ent. Res.* **50** pt. 4 pp. 687–696, 1 graph, 26 refs. London, 1960.

The following is largely based on the author's summary. The sharply defined biting cycle shown by outdoor populations of *Aëdes aegypti* (L.) in Uganda [*R.A.E.*, B **47** 150], which closely resembles the oviposition and general activity rhythms, could not be reconciled with the ill-defined cycles found in domestic populations on the Kenya coast [**44** 6; **46** 29; **47** 22]. In the absence of knowledge of the composition of the population on the coast, 24-hour catches with human bait were made at Ganda, and the abdominal pattern of each individual was noted. Of the 427 females of *A. aegypti* taken biting, 82·1 per cent. were of var. *queenslandensis* (Theo.) (comprising 75·3 per cent. with the lateral abdominal spots silver and 6·8 per cent. with them white *), 14·5 per cent. of the type form and 0·9 per cent. of subsp. *formosus* (Wlk.) [*cf.* **47** 19]. In the series, there was gradation from the darkest example of subsp. *formosus* to the palest of var. *queenslandensis*. Very similar biting cycles, with the main peak in the hour before sunset, occurred both inside a hut and within an adjacent compound, although catches were not concurrent and were made under different seasonal conditions. The distribution of the various colour forms in the total catch was independent of the hour of capture.

There is a resemblance between these cycles and the cycles reported by J. P. T. Boorman in comparable situations in Nigeria. It is concluded that subsidiary biting peaks, when present, occur with increasing intensity as the day progresses, and that the main peak is shortly before sunset. The relation of biting to other aspects of general activity is discussed, and it is concluded that several aspects require further investigation. To account for the various patterns of biting cycle observed in different situations, it is suggested that *A. aegypti* has an endogenous multi-peaked 24-hour rhythm of activity, that the endogenous activity impulses occur in a cycle of waves of increasing intensity from dawn onwards, reaching a maximum at the end of the daylight period, and that a biting peak will result when such an impulse coincides with environmental conditions within the range between the upper and lower thresholds of activity.

Lewis (D. J.) & Garnham (P. C. C.). **The Simuliidae (Diptera) of British Honduras.**—*Bull. ent. Res.* **50** pt. 4 pp. 703–710, 1 map, 19 refs. London, 1960.

Records are given of Simuliid pupae and adults collected during January and February 1958, in two areas in the west of British Honduras and along

* We are informed by the author that, in the table concerned, the numbers in which the spots were silver and white, respectively, were transposed.– *Ed.*

the highway in the east. More than 250 collected or bred adults and 648 pupae or pupal skins were identified and found to include material of 13 species of *Simulium*, four of which were provisionally left unnamed. The known distribution in British Honduras of each of the 13 species is given. Two species, *S. quadrivittatum* Lw. and *S. metallicum* Bellardi, cause considerable annoyance by their bites, which give rise to intense irritation. *S. quadrivittatum* was widely distributed and abundant and seems to flourish among hills of moderate height. Immature stages of this species were rarely found. The few pupae taken were in very small streams, as were pupae of *S. metallicum*. A single female of *S. veracruzanum* Vargas, Martínez and Díaz was taken biting man, and *S. callidum* (D. & S.) was present but was not taken on man [*cf. R.A.E.*, B **44** 47, etc.].

Onchocercosis [caused by *Onchocerca volvulus*] has apparently never become established in British Honduras, but it is prevalent in man and causes a considerable amount of blindness some 200 miles away in Guatemala. *S. metallicum* is regarded as a vector of secondary importance there [**44** 47], but nothing is known of the ability of *S. quadrivittatum* to serve as a vector. Development and road building in British Honduras will allow people to settle in areas infested by *Simulium* that are now sparsely inhabited, but the possibility that onchocercosis will become established in that country, which is much lower than the infected parts of Guatemala, cannot be assessed until the epidemiology of the disease in Central America is better known.

Haddow (A. J.). **Studies on the biting habits and medical importance of East African mosquitos in the genus *Aëdes*. I. Subgenera *Aëdimorphus*, *Banksinella* and *Dunnius*.**—*Bull. ent. Res.* **50** pt. 4 pp. 759–779, 5 graphs, 57 refs. London, 1960.

The following is partly based on the author's summary. The biting behaviour of East African species of *Aëdes* in the subgenera *Aëdimorphus*, *Neomelaniconion* (*Banksinella*) and *Dunnius*, as shown in numerous series of 24-hour catches made predominantly in Uganda, is discussed. In the analysis of the results of long series of catches, use is made of the measure described in an earlier paper [*R.A.E.*, B **42** 61] as "the geometric mean as modified by C. B. Williams", and in an appendix the term 'Williams' mean', symbolised by M_w, is proposed for future use. It is shown that with the exception of *Aëdes natronius* Edw., which is arboreal, the species encountered were most prevalent at ground level. They bit mostly by day, but *A. cumminsi* (Theo.) showed a marked peak of activity from just before to just after sunset, and *A. natronius* was crepuscular. When, however, samples were obtained in environments that were less favoured than the forest floor, the biting cycle tended to be altered. Thus, various species that were essentially diurnal at ground level in forest were nocturnal in the canopy and possibly in banana plantations. In some cases, there seemed to be a tendency towards a group pattern of behaviour.

Members of all three subgenera have been involved in various isolations of virus, but it is not possible to prove that they, rather than other species of *Aëdes* included in the infected lots, were the vectors, except in the case of the group of *A.* (*Aëdimorphus*) *tarsalis* (Newst.), from which there have been two isolations of the virus of Rift Valley fever in Bwamba [*cf.* **48** 11], and in that of *Aëdes* (*Neomelaniconion*) *circumluteolus* (Theo.), which has been shown by recent work in South Africa [**48** 69–72] and East Africa to be of major importance, well over 20 isolations of virus having been made from it. So far as is known at present, seven separate viruses (Bunyamwera, Semliki, Pongola, Simbu, Wesselsbron and Middelburg

viruses and the virus of Rift Valley fever) and a variant of the last [**47** 182] have been isolated from *A. circumluteolus*. The isolation of Middelburg virus from a pool consisting of *A. lineatopennis* (Ludl.) and *A. albothorax* (Theo.) or a species near it [**48** 72] is the first instance of the definite incrimination of other species of *Neomelaniconion*.

A. circumluteolus was the most prevalent species of *Neomelaniconion* found during the work in Uganda. It was particularly common in catches made with moving baits, but less so in 24-hour catches with stationary bait [*cf.* **48** 70]. It bites freely in bush, forest and plantations and in the open. Forest appeared to be the preferred habitat in Uganda. It bit throughout the 24 hours, but was most active by day, with a general tendency towards heightened activity in the late afternoon. In the canopy, the cycle was nocturnal, as it also tended to be in plantations. Epidemiological evidence is given showing that it is the species most likely to have been responsible for the presence of Bunyamwera virus in the pool of mixed mosquitos from Bwamba from which this virus was originally isolated [**37** 150]. Bunyamwera virus can cause severe encephalitis in man with residual mental symptoms and is widespread in Africa.

Mellanby (K.). **Acclimatization affecting the position of the cold and heat death points of larvae of** *Aëdes aegypti* **(L.).**—*Bull. ent. Res.* **50** pt. 4 pp. 821–823, 7 refs. London, 1960.

The following is substantially the author's summary. In experiments with *Aëdes aegypti* (L.), fourth-instar larvae bred at 30°C. [86°F.] survived exposure to 0·5°C. [32·9°F.] for seven hours, but none recovered after exposure for 17 hours, although nearly all those from the same culture that had been acclimatised for 24 hours at 18 or 20°C. [64·4 or 68°F.] did so. No such effect followed acclimatisation at 10°C. [50°F.], at which larvae went into chill coma. Larvae acclimatised at 18°C. survived exposure to 5°C. [41°F.] for longer than did those from 30°C. Earlier work showed that the thermal death point, for a one-hour exposure, was 42°C. [107·6°F.] for larvae acclimatised at 30°C. but rose to 44°C. [111·2°F.] for larvae acclimatised at 37°C. [98·6°F.]. It is concluded that the effects of high or low extremes of temperature may be substantially modified by a brief period of acclimatisation at a less extreme temperature.

Hafez (Mahmoud). **On the susceptibility of the Egyptian house-fly,** *Musca domestica vicina* **Macq., to several insecticides (Diptera).**—*Bull. Soc. ent. Egypte* **42** pp. 75–81, 6 graphs, 9 refs. Cairo, 1958.

Studies were carried out in Egypt on the susceptibility to six insecticides of adults of *Musca domestica vicina* Macq. from a laboratory culture. The insecticides were applied topically to the mesonotum as acetone solutions by means of a wire loop giving drops of constant volume and measurable insecticide content. The flies, which were 2–3 days old, were anaesthetised with carbon dioxide, placed after treatment in ventilated cartons with damp cotton-wool and a lump of sugar, and examined for mortality after 24 hours at 26–29°C. [78·8–84·2°F.] and 50–60 per cent. relative humidity. The sexes were tested separately in batches of 20. The LD50's of DDT, methoxy-DDT (methoxychlor), γ BHC (lindane), dieldrin, parathion and a 1:8 mixture of pyrethrins and piperonyl butoxide were 0·815, 0·264, 0·0766, 0·0827, 0·0009 and 0·2214 μg., respectively, for females, and

0·692, 0·188, 0·055, 0·0556, 0·0008 and 0·1863 μg. for males. The LD50's of the first four insecticides for the females were 25, 4, 7·5 and 2·5 times as great, respectively, as those recorded for a susceptible strain of *M. domestica* L. [*R.A.E.*, B **43** 194].

Hafez (Mahmoud) & Attia (M. A.). **Studies on the ecology of *Musca sorbens* Wied. in Egypt (Diptera: Muscidae).**—*Bull. Soc. ent. Egypte* **42** pp. 83–121, 5 graphs, 85 refs. Cairo, 1958. **On the developmental stages of *Musca sorbens* Wied., with special reference to larval behaviour (Diptera: Muscidae).**—*T.c.* pp. 123–161, 22 figs., 51 refs. **The relation of *Musca sorbens* Wied. to eye diseases, in Egypt (Diptera: Muscidae).**—*T.c.* pp. 275–283, 3 graphs, 20 refs.

The first of these papers on *Musca sorbens* Wied. in Egypt is prefaced by notes on its taxonomy and world distribution and by a review of the literature on its association with man. Observations on the habits of the adults were made in 1953–56, mainly in the field, at Talbia (near Cairo), but also in various localities in towns, cultivated areas and the desert, and in the laboratory. *M. sorbens* is seldom encountered in Egypt in houses and showed a preference for sunlit situations in the open, although it frequented food stores, abattoirs and open spaces in urban areas, especially where there was no system of sewage disposal and defaecation occurred on waste sites among houses. In desert areas, it formed 60·2 per cent. of the fly population, of which the other constituents were *M. domestica vicina* Macq., *M. xanthomelas* Wied. and *Sarcophaga* and *Wohlfahrtia* spp. *M. d. vicina* is more numerous in urban areas, but *M. sorbens* causes greater annoyance to man, as it persistently settles on the body and is attracted to ulcers and wounds and to the eyes, mouth and nostrils [*cf. R.A.E.*, B **28** 250; **43** 178]. Counts in the open at Talbia with a Scudder grill [*cf.* **38** 158] showed that *M. sorbens* occurred throughout the year with peak populations in April and August. Although it was outnumbered by *M. d. vicina*, weekly catches of flies attracted to the eyes of children suffering from eye disease showed that in these it was the dominant species throughout the spring and summer.

Details are given of laboratory studies on the temperature tolerance and colour preferences of the adults of *M. sorbens* and on the factors governing their emergence and mating, the preoviposition period and oviposition. At a relative humidity of about 50 per cent., the length of life of the males was 18–36 days and of the females 28–45 days at 24°C. [75·2°F.], and 6–12 days for both sexes at 36°C. [96·8°F.]. Caged flies lived for an average of 13·5 days when they were fed with sucrose and water, 2 days when allowed water only, and 0·9 days on human excrement or buffalo dung, so that it would appear that dung is visited only for oviposition. Flies died within 15–44 hours of emergence when denied food and water. The flight range of *M. sorbens*, examined by releasing marked adults in open country, was about 1·2 miles in 1–2 hours and nearly 2 miles in 2–3 days [*cf.* **45** 78]. Although about equal numbers of males and females were reared from natural and artificial media, females comprised 67–80 per cent. of the catches in the field.

Of flies emerging from human faeces during the summer, *M. sorbens* appeared first, followed by *M. d. vicina*. *M. sorbens* normally deposits its eggs on human faeces, but is seldom attracted to stools more than two days old. Females lay 1–5 batches each, single batches containing up to 32 eggs. Laboratory experiments showed that no eggs were laid on faeces with a moisture content outside the range of 30–75 per cent., and that 40 per cent. was optimal. In tests of a variety of substrates in the laboratory,

89·4 per cent. of the eggs were laid on human faeces, 6·9 per cent. on pig dung, 3·7 per cent. on calf dung and none on that of horse, donkey, buffalo, cow, camel or chicken, although fuel cakes of cow and buffalo dung, exposed in the open, were later found to contain larvae in moderate numbers. These findings were substantiated in the field, where the examination of latrine dumps, isolated human faeces, sewage disposal farms, horse and donkey stables, pig sties, cow and buffalo byres, camel sheds and house refuse [*cf.* **27** 164] showed that *M. sorbens* breeds mainly in human faeces. For rearing the fly in the laboratory, a 1:2 mixture of coarse bran and milk that had been diluted with half its quantity of water proved a successful substitute for the latter.

In the second paper, the bionomics of the immature stages of *M. sorbens* are described. High humidity was essential for the incubation and hatching of the eggs; at 31–32°C. [87·8–89·6°F.], all hatched at 96 per cent. relative humidity, whereas none did so at 85 per cent., and this may perhaps be explained by changes in egg shape and stress induced by decrease in humidity [*cf.* **40** 203]. At 30°C. [86°F.], the eggs tolerated short exposures to 30 per cent. relative humidity; thus, when they were exposed for 10 minutes, 90 per cent. hatched, but after 40 minutes exposure, only 17 per cent. did so, and after 50 minutes, none, and these effects were due to actual water loss from the eggs. The duration of the three larval instars decreased from an average of 268 hours at 16°C. [60·8°F.] to 69 at 36°C. [96·8°F.], but increased to 73 at 40°C. [104°F.]; it was prolonged for several days when larvae about to pupate were not provided with the drier soil suitable for pupation. The threshold of development and thermal constant for the larvae were 9·2°C. [48·56°F.] and 70·3 day-degrees C. [126·54 day-degrees F.] [*cf.* **32** 134]. Larvae were able to withstand a temperature of 0°C. [32°F.] for six hours with no apparent harm.

Adults were reared in the laboratory from larvae fed on artificial media; the highest percentage from larvae reared on a mixture of 60 g. wheat bran and 1 g. dried yeast was 60 as compared with 74 and 47 from those reared on human faeces and buffalo dung, respectively. Without food, but in a moist habitat, first-instar larvae moulted after about 10 hours and then died, whereas in a dry habitat death occurred within a few minutes.

In studies of behaviour under laboratory conditions, larvae reared in the milk-bran mixture were kept at uniform humidities or temperatures, or were offered the choice between pairs of humidities or temperatures. At 28°C. [82·4°F.], feeding larvae preferred relative humidities near saturation, but those about to pupate preferred humidities of 50–60 per cent. Feeding larvae were attracted by human faeces, milk, ammonia, acetone, indole, skatole and alcohol, and were repelled by acetic and formic acids, but fully grown larvae were less strongly attracted and did not react to the repellents.

Pupae were mostly found within 3 cm. of the surface of the soil, but sometimes occurred as far down as 20 cm. The duration of the pupal stage, which was not affected by changes in relative humidity, was, on average, 6·2 days at 24°C. [75·2°F.] and 4·6 days at 28°C. [82·4°F.] and within this range 89·5–94·7 per cent. gave rise to normal adults, as compared with 36·6 per cent. for pupae kept at 16°C. [60·8°F.] and 44·3 per cent. at 36°C. [96·8°F.]. No adults emerged from pupae kept at 40°C. [104°F.].

In the third paper, the probable rôle of *M. sorbens* in the transmission of eye diseases [*cf.* **43** 178] in Egypt is considered. *M. sorbens* comprised over 80 per cent. of the flies collected from eyes in March, April and June, over 70 per cent. in February, May and August, and 55 per cent. in October; *M. d. vicina* was almost the only other species involved. There was also a direct correlation between the seasonal abundance of *M. sorbens*

and the numbers of admissions of children suffering from eye diseases to a hospital in Cairo and between the population density of *M. sorbens* and the incidence of eye diseases in urban areas, both with and without sewage disposal systems. Adult flies favoured secretions from diseased eyes when presented with a choice of attractants in the laboratory, and the attraction was caused by an olfactory rather than by a humidity response since slightly more (59–69 per cent.) flies of both sexes preferred the drier of two humidities offered them in various portions of the relative humidity scale. Earlier investigations by J. D. DeCoursey and others had shown that in April–June and August bacteria associated with ophthalmia occurred more abundantly on *M. sorbens* than on *M. d. vicina*.

Abdel-Malek (A. A.). **The Anopheline mosquitoes of northern Syria.**—*Bull. Soc. ent. Egypte* **42** pp. 519–535, 4 maps, 16 refs. Cairo, 1958.

This paper, which is prefaced by notes on the topography and climate of the region, contains the results of a survey of Anophelines carried out between March 1953 and December 1954 in an area of Syria extending from Homs north-westwards to the Turkish frontier and north-eastwards to the Iraqi frontier. Previous records from the literature are reviewed [*cf. R.A.E.*, B **13** 17; **24** 231–232]. *Anopheles maculipennis sacharovi* Favr, *A. superpictus* Grassi, *A. hyrcanus* (Pall.), *A. pulcherrimus* Theo. and *A. claviger* (Mg.) [*cf.* **46** 216] comprised about 57, 32, 7, 2 and 1·5 per cent., respectively, of the adults and larvae collected, while *A. algeriensis* Theo. was taken only once, in a reed swamp near Homs. Adults of *A. pulcherrimus* had not previously been taken in Syria. Maps show the distribution of each species within the surveyed region.

Larvae of *A. m. sacharovi* were found in fresh water [*cf.* **38** 131] at 101 breeding sites in marshes, lake margins and rice-fields in unshaded situations, in marshy areas of rivers and lakes with emergent or floating vegetation, especially in the Ghab swamp, and in shaded or unshaded reaches of neglected irrigation canals. Adults frequented houses and stables, usually in association with *A. superpictus*, and were never taken in the open at a distance from such habitats. The population increased from May to a peak in October, and then declined, but hibernating females were observed in buildings in November–February. Larvae of *A. superpictus* were found in 48 breeding sites in slow-running surface waters, sometimes with emergent vegetation, and at one site in water-filled hoof prints; they were also collected in August–September 1953 from slow-moving, sunlit mountain streams near the northern border of the Lebanon. The habitats and seasonal abundance of *A. superpictus* were similar to those of *A. m. sacharovi*, but the first species was also found in caves in the vicinities of Homs and Hama. *A. hyrcanus* occurred only in the Orontes valley, where larvae were usually found in association with *A. m. sacharovi* and *A. superpictus*. The adults frequented houses only in small numbers, but attacked man and domestic animals in the open at dusk and dawn and sometimes even during the day. *A. pulcherrimus* was restricted to the governorates of Euphrates and the Jezireh, where larvae were found associated with *A. m. sacharovi* and *A. superpictus* in shallow pools and at the edges of irrigation canals with emergent vegetation and floating algae, and adults were caught in buildings in October. Larvae of *A. claviger* occurred at only five sites, in shaded waters, and adult females were found in November–February in caves and a stable; the distribution of this species appeared to be restricted to the areas around Homs, Hama and Latakia. Keys are given for the separation of adults and fourth-instar larvae of the Anophelines recorded from Syria, including *A. marteri* Sen.

& Prun. [*cf.* **46** 131] and *A. sergentii* (Theo.), in addition to the six mentioned.

Penner (L. R.). **Concerning a rabbit Cuterebrid, the larvae of which may penetrate the human skin (Diptera, Cuterebridae).**—*J. Kans. ent. Soc.* **31** no. 2 pp. 67–71, 12 figs., 2 refs. Manhattan, Kans., 1958.

A species of *Cuterebra*, probably *C. buccata* (F.), is associated with rabbits in Kansas. When three first-instar larvae were placed in the skin crease on the author's forearm, complete penetration was effected by one in 18 minutes, but only two-thirds penetration by the other two, which were removed after 18 and 25 minutes, respectively. On 14th July, eight first-instar larvae were placed on the fur and in the ears of two domestic rabbits, and 22 were disposed on a third, ten on the inner side of one ear, eight on the fur and two in each nostril; although entry through the skin was not observed, two second-instar larvae were found, one under the skin of each foreleg, on the third rabbit after its death on 20th July, and the other two rabbits developed sero-purulent sores containing five and four larvae, one of which was full-fed on 13th August and dropped out on the next day. The others were apparently eaten by the rabbits.

Lofgren (C. S.) & Burden (G. S.). **Tests with poison baits against cockroaches.**—*Florida Ent.* **41** no. 3 pp. 103–110, 2 refs. Gainesville, Fla., 1958.

The tests described were carried out in Florida, and the following is based on the authors' summary of the results. In laboratory tests with a variety of baits incorporating 2 per cent. trichlorphon (Dipterex), powdered sugar was the most attractive to *Blattella germanica* (L.) and dextrin and maize starch, alone or mixed, were the most attractive to nymphs of *Periplaneta americana* (L.). In houses, baits incorporating 1 per cent. trichlorphon proved unsatisfactory against *B. germanica*, but baits of granulated sugar or mixtures of maize meal with Coca-Cola syrup, powdered sugar or white Karo syrup, all containing 1 per cent. trichlorphon, effectively reduced mixed populations of *P. americana*, *P. brunnea* Burm. and *P. australasiae* (F.). Similar baits containing 2 per cent. trichlorphon gave 75–95 per cent. control of *Periplaneta* spp. in dairy barns, whereas baits containing 2 per cent. malathion were inferior.

Roulston (W. J.), Norris (K. R.), Schnitzerling (H. J.) & Meyers (R. A. J.). **Comparison of two formulations of DDT as dipping fluids for the control of the cattle tick.**—*Aust. J. agric. Res.* **9** no. 4 pp. 587–598, 2 graphs, 10 refs. Melbourne, 1958.

Suspensions of two formulations of technical DDT, one a colloidal paste that had to be melted before addition to the water (A) and the other a wettable powder (B), were compared in southern Queensland as dips for the control of *Boophilus microplus* (Can.) on cattle. The concentration of p,p′DDT in the fluid was maintained at 0·5 per cent., and dipping was at fortnightly intervals, as in an eradication campaign. The results showed that fertile females matured on cattle dipped in preparation B, but not on those dipped in preparation A, although numerous larval ticks attached themselves to the animals between dippings. The difference in performance, the causes of which are discussed, is thought to be attributable largely to differences

in the amounts of DDT left on the hair of the cattle by the two formulations. Samples of hair taken immediately after the cattle had been dipped in B bore practically uniform amounts of DDT throughout the series of dippings. Samples taken after the first dip in A bore amounts of DDT of the same order as did those from the cattle dipped in B, but the deposits left by subsequent dippings were much heavier, because the DDT had passed from the colloidal to the crystalline state, a relatively rapid proceeding that results in filterable crystals of which 90 per cent. exceed 45 μ in size. There was a marked increase in deposits of DDT in the hair a fortnight after a freshly mixed preparation A had been added, except after the replenishment on the occasion of the 9th dipping. Crystals already in the vat probably acted as nuclei accelerating further crystal growth. After the vat had remained unused for a long period, the amount of DDT deposited on the hair was the same as before the resting period. The concentration of DDT in the drippings from animals dipped in formulation A contained lower concentrations of DDT than did the vat fluid, irrespective of age, and this effect was even more marked with dips of formulation B 84–154 days old, though it did not occur at all when this dipping fluid was fresh. There was, therefore, with both formulations, a differential retention of toxicant, as against water, as the fluid drained off the cattle. The amounts of DDT that remained on the hair a fortnight after dipping were of the same order for both preparations, and showed a progressive increase with increasing age of the dipping fluid. Possible reasons for this are discussed, but no entirely satisfactory explanation could be given; the suggestions include saturation of the fatty tissues under the skin with DDT, leading to decreased absorption of the toxicant while at the same time increasing its secretion on to the hairs, and a reduction in size of the DDT particles, giving rise to deposits that were more securely anchored, and therefore more persistent.

Alford (H. G.) & Jones (C. M.). **Horn fly control with Bayer 21/199.**— *Agric. Chem.* **14** no. 2 pp. 53, 127, 2 refs. Baltimore, Md., 1959.

In the summer of 1957, 19 herds containing over 5,000 beef cattle in central and north-western Nebraska were sprayed with Bayer 21/199 [O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl phosphorothioate] in an investigation to determine whether a single application would control both *Siphona irritans* (L.) and *Hypoderma lineatum* (Vill.) and *H. bovis* (Deg.). The cattle, which were of all ages and were in large pastures on 14 ranches, were sprayed in pens in batches of 15–20 with 0·25, 0·5 or 0·75 per cent. suspensions at an average rate of about 2 U.S. quarts spray per animal. The effect on *Siphona* is described. The lowest and middle concentrations were applied to eight herds between 17th June and 24th July and to seven herds between 18th June and 16th August and gave control for periods ranging from 9 to 40 and 12 to 36 days, respectively; these periods varied at the same, as well as at different, locations. The periods of protection conferred by second applications made to a few herds when the first became ineffective fell within the same limits. The highest concentration was applied to only one herd on 1st July, and it remained effective for 53 days. Three herds sprayed with 0·5 per cent. methoxy-DDT (methoxychlor) as a standard of comparison were protected for 13–40 days. The criterion of failure was the finding of 50 flies or more on at least half the cattle. Infestation before treatment was at the rate of about 200–500 flies per animal. Moderate or heavy rain sometimes fell a few days after spraying, but this did not seem to be the primary cause of the erratic results.

Peters (W.) & Standfast (H.). **Report on a malaria survey in the Sepik District.**—*Med. J. Aust.* June 22, 1957 pp. 861–868, 17 refs. Sydney, 1957.

Peters (W.), Christian (S. H.) & Jameson (J. L.). **Malaria in the Highlands of Papua and New Guinea.**—*Op. cit.* September 27, 1958 pp. 409–416, 3 figs., 18 refs. 1958.

An account is given in the first paper of a malaria survey carried out in April 1956 in the Sepik district of northern New Guinea. The spleen rate was found to be 100 per cent. in children 2–4 years old and was above 40 per cent. in every age group. Parasite rates were also 100 per cent. in children 2–4 years old in two of the three localities in which this age group was examined and were rarely below 50 per cent. in any group, except in schoolchildren that were treated with antimalarial drugs when showing symptoms of fever. *Plasmodium falciparum*, *P. vivax* and *P. malariae* were present in all age groups. *P. falciparum* was the dominant species in infants and young children, and *P. malariae* was generally the commonest in adults. The gametocyte rate was high in all age groups.

Mosquito collections showed *Anopheles punctulatus* Dön. and *A. koliensis* Owen, which were caught in moderate numbers, to be the dominant vectors inland, and *A. farauti* Lav. to be by far the commonest species on the coast, where it occurred in large numbers. All three were taken biting in day-time near the Sepik river and resting in houses. A single female of *A. karwari* (James), taken during a night collection, constituted the first record of this species east of the border with Netherlands New Guinea, where it is a recognised vector. Recent collections have also shown that *A. subpictus* Grassi is present at Wewak. *Mansonia* (*Taeniorhynchus*) *uniformis* (Theo.) was abundant in the Sepik plains. In random larval collections made during the survey, *A. punctulatus* was found breeding in water in wheel ruts exposed to the sun and covered with a mat of filamentous green algae and was also taken among stones at the edge of the river in clean flowing water with no vegetation. During subsequent collections at Wewak, larvae of both this species and *A. farauti* were found in brackish and fresh water, of *A. koliensis* in fresh water and of *A. bancroftii* Giles in a swamp, the water of which was only very slightly salt. The findings in this survey and in earlier ones [*cf. R.A.E.*, B **44** 193] are discussed in relation to the definition of endemicity in the area [*cf.* **44** 191], and problems requiring study are set out.

Descriptions are given in the second paper of the topography, climate and inhabitants of the highlands of Papua and New Guinea, and the altitude limit of malaria there is discussed. Regulations concerning the employment of highland labourers in coastal New Guinea are based on the assumption that the upper limit of malaria is at about 3,500 ft. Though it appears to occur at altitudes as high as 6,000–6,500 ft., the disease is not endemic in some areas at 5,500 ft., and the frequency of transmission above 3,500 ft. is too low to allow the population to develop a high degree of immunity. Epidemics occur from time to time in the marginal areas. Incidence is seasonal, and little information is available on the relations of vector density to malaria prevalence. Six species of *Anopheles* are listed as occurring in the highlands, and these include *A. punctulatus*, *A. farauti* and an intermediate form, which is perhaps *A. koliensis*. These three have been proved to transmit malaria in the highlands, as elsewhere in the territory. Their distribution is sporadic. *A. farauti* occurs up to about 6,500 ft. and maintains a low perennial endemicity. *A. punctulatus* is found up to almost the same altitude but is more seasonal in its occurrence and may be responsible for seasonal epidemics. There is some

evidence that, with the development of the highlands by Europeans, endemic malaria is spreading. Factors that may lead to an extension of transmission are reviewed. Those relevant to local conditions include the introduction of malaria parasites, an increase in the vector population (largely through the extension of man-made breeding places), climatic changes and immigration of non-immune people. Reference is made to the legislation that exists to control the movement and medical care of highland labourers entering coastal areas and their subsequent repatriation, and mention is made of some of the natural factors that may limit the extension of malaria in the highlands; these include possible limitation of the development of the parasite in the vector by the cool climate, dispersion of population in small hamlets, tribal isolation and perhaps inhibition of the pre-erythrocyte cycle by altitude [*cf.* **46** 34.]

Heisch (R. B.), McMahon (J. P.) & Manson-Bahr (P. E. C.). **The isolation of *Trypanosoma rhodesiense* from a bushbuck.**—*Brit. med. J.* Nov. 15, 1958 pp. 1203–1204, 1 ref. London, 1958.

Trypanosoma rhodesiense, the cause of Rhodesian sleeping sickness, differs from *T. brucei* only in its ability to infect man. It has long been believed to have an animal reservoir but has so far not been isolated from wild game animals. In a recent investigation, a strain of the *brucei* group was isolated from 74 animals shot in two areas of endemic sleeping sickness in Tanganyika, but since this did not infect man it was presumed to be *T. brucei*. In the experiment here described, 24 animals were shot on the Utonga Ridge, about 40 miles west of Kisumu in Kenya, an area in which Rhodesian sleeping sickness occurred and which had been selected because *T. rhodesiense* had been isolated from the locally predominating tsetse, *Glossina pallidipes* Aust. Three strains of trypanosomes of the *brucei* group were isolated, one from a duiker and two from bushbuck (*Tragelaphus scriptus*); each was inoculated into a human volunteer and one of the men receiving trypanosomes from a bushbuck became infected.

Papers noticed by Title only.

Iyengar (M. O. T.). **Annotated bibliography of filariasis and elephantiasis** [due to *Wuchereria bancrofti* and *W. malayi*]. **Part 4. Treatment.**—*Tech. Pap. S. Pacif. Comm.* no. 124, xii + 177 pp., multigraph. Nouméa, 1959. [*Cf. R.A.E.*, B **44** 181; **46** 100.]

Moore (B. P.) & Hewlett (P. S.). **Insecticidal synergism with the pyrethrins: studies on the relationship between chemical structure and synergistic activity in the 3:4-methylenedioxyphenyl compounds.**—*J. Sci. Fd Agric.* **9** no. 10 pp. 666–672, 1 graph, 25 refs. London, 1958. [*Cf. R.A.E.*, A **48** 150.]

Hawes (I. L.). **Index XII to the literature of American economic entomology 1952.**—*Spec. Publ. ent. Soc. Amer.* no. 12, [8+] 321 pp., frontis. Washington, D.C., 1954. **Index XIII . . . 1953.**—*Op. cit.* no. 13, [7+] 303 pp. 1955. **Index XIV . . . 1954.**—*Op. cit.* no. 14, [7+] 306 [+6] pp. 1956. **Index XV . . . 1955.**—*Op. cit.* no. 15, [7+] 329 [+6] pp., frontis. 1957. Cushman (H. G.). **Index XVI . . . January 1, 1956–December 31, 1957.**—*Op. cit.* no. 16, [10+] 694 pp. 1959. [*Cf. R.A.E.*, B **43** 184.]

Senevet (G.), Andarelli (L.) & Graëlls (R.). **A propos de *Culex pipiens* en Algérie.**—*Arch. Inst. Pasteur Algérie* **36** no. 1 pp. 70–74, 2 figs., 7 refs. Algiers, 1958.

Knowledge of the mosquitos of the complex of *Culex pipiens* L. in North Africa is fragmentary. In Tunisia, Vermeil found an autogenous form in the north and a form resembling *C. p. pipiens* in the south [*R.A.E.*, B **44** 81]. Roubaud described *C. p. berbericus* from Algeria [**21** 267], and this form was later recorded from Antibes, in the south of France, but Clements and the present authors have found various Algerian populations of *C. pipiens* to differ in larval chaetotaxy from *C. p. berbericus* from France. Using a fresh character, the shape of the lateral phallosome plates (dorsal process of the mesosome), described by Christophers in 1951, in a paper already noticed [**40** 66], for separating *C. p. pipiens* from *C. p. molestus* Forsk., the authors found that the Algerian material conformed with *C. p. pipiens* and not with *C. p. berbericus* from France, which had been shown by Roubaud & Ghelelovitch [*C. R. Acad. Sci.* **245** pp. 7–9, Paris, 1957] to resemble *C. p. molestus* in this respect. The 140 hypopygia examined came mainly from rural areas, which were situated in the Sahara region as well as around Algiers and Oran. It is concluded that Algerian populations probably comprise a complex mixture of races requiring further study [*cf.* **44** 81, etc.].

Nagahana (M.), Toyama (H.) & Ishigami (K.). **On the breeding grounds of biting black gnat, *Leptoconops nipponensis* Tokunaga (Ceratopogonidae, Diptera).**—*J. Yonago med. Ass.* **10** no. 1 pp. 177–178. 1959. (Abstr. in *Yonago Acta med.* **4** no. 1 pp. 66–67. Yonago, 1959.)

Ishigami (K.). **On the morphology and ecology of the biting black gnat *Leptoconops nipponensis* Tokunaga (Ceratopogonidae).**—*J. Yonago med. Ass.* **10** no. 1 pp. 179–203. 1959. (Abstr. in *Yonago Acta med.* **4** no. 1 p. 67. Yonago, 1959.)

Nagahana (M.), Ishigami (K.) & Toyama (H.). **On the geographical distribution of biting black gnat, *Leptoconops nipponensis* Tokunaga and on the human blood sucking habits of the species.**—*J. Yonago med. Ass.* **10** no. 1 pp. 207–208. 1959. (Abstr. in *Yonago Acta med.* **4** no. 1 p. 67. Yonago, 1959.)

In the first paper, the authors record the discovery of larvae and pupae of *Leptoconops nipponensis* Tokunaga in the city of Yonago, Tottori Prefecture, Honshu, at a depth of 0–25 cm. in sandy soil in fields in which the ground-water level was close to the surface. In the second, all stages of this Ceratopogonid, of which only the adult female was hitherto known, its life-history and habits are described. In the third, its occurrence at various places in Tottori and three other prefectures in south-western Honshu is recorded, and the female is reported to bite man.

Sömme (L.). **Resistance to chlorinated insecticides in Norwegian house-flies.**—*Nytt Mag. Zool.* **8** pp. 56–60, 9 refs. Oslo, 1959.

During the autumn of 1957, house-flies [*Musca domestica* L.] were collected on ten farms in southern Norway and the susceptibility of their second-generation progeny to insecticides was tested by topical applications of DDT, γ BHC (lindane), chlordane and dieldrin. Chlorinated-hydrocarbon

insecticides had been in use in Norway for about ten years but were being abandoned or superseded by phosphorus compounds in many places, as they no longer seemed to be giving adequate control. On most of the farms concerned, they had not been used for the past two or three years. Very few of the strains showed resistance to any of the insecticides on the basis of the LD50, but the slope of the log-probit line plotted from dosage and mortality data provided evidence of a large genetical heterogeneity [*cf. R.A.E.*, B **45** 27] in several strains, possibly indicating that they had been more resistant formerly. This assumption was supported by the results of three attempts at selection, in which a DDT-selected strain became 20 times as resistant in three generations, a strain selected for γ BHC 30 times as resistant in six generations and a chlordane-selected strain more than 215 times as resistant in three generations. It is concluded that Norwegian house-flies develop resistance to chlorinated insecticides in a way similar to that reported from other countries.

The reference collection of insects in the Faculty of Agriculture, University College, Ibadan.—*Divl Rep. Fac. Agric. Univ. Coll. Ibadan* no. 4 (Ent.), [1 +] 61 pp., multigraph. Ibadan, 1959.

The reference collection of insects in the faculty of agriculture of University College, Ibadan, Nigeria, was established in 1951 with a gift representing about 100 known pests that occur in West Africa, and has since been supplemented by identified material collected locally, mostly from crops and livestock. It now comprises some 2,000 species, a list of which is given.

Metcalf (R. L.). Ed. **Advances in pest control research. Volume II.**—9¼ × 6 in., vii + 426 pp., 110 figs., many refs. New York, N.Y. & London, Interscience Publishers, Inc., 1958. Price £4 14*s*.

The articles in this second volume of a series [*cf. R.A.E.*, B **45** 156] include **Isotope dilution techniques for the determination of pesticide residues,** by C. T. Redemann & R. W. Meikle (pp. 183–206, 6 figs., 16 refs.), in which a method of residue determination involving dilution of the material initially present in the sample with a precisely known quantity of a particular isotopic form (either stable or radioactive) of the same substance is described, with particular reference to the dilution of non-radioactive residues with radioactive isotopes, and illustrated from work with a herbicide; **Chemical structure and activity of DDT analogues with special consideration of their spatial structures,** by R. Riemschneider (pp. 307–350, 27 figs., 50 refs.), who concludes that there is a correlation between the contact toxicity of DDT analogues and the degree of rotatability of their molecular components, which is supported by measurement of dipole moments of suitable analogues, and consequently that the configuration of such analogues can be taken as a further criterion for judgement of their activity; and **The spread of insecticide resistance in pest species,** by A. W. A. Brown (pp. 351–414, 564 refs.), which consists primarily of a review of the large number of insects, mites and ticks in which the development of resistance to insecticides has been demonstrated or claimed and of some that are remarkable for lack of induced resistance. In addition to a subject index, a cumulative index of the articles appearing in the two volumes so far published is included.

Stone (A.), Knight (K. L.) & Starcke (H.). **A synoptic catalog of the mosquitoes of the world (Diptera, Culicidae).**—*Thomas Say Foundn* **6**, 9¼ × 6 in., [5+] 358 pp., 37 pp. refs. Washington, D.C., Ent. Soc. Amer., 1959. Price $7.25 (+ 50*c*. postage outside U.S.).

This is the first world catalogue of mosquitos to appear since the one published by Edwards in 1932 [*R.A.E.*, B **21** 1], and in the intervening years many new species and other taxa have been described, previously unknown stages discovered and synonymies recognised, and there have also been some changes in classification. This new knowledge is incorporated into the present work, in which 111 valid genera and subgenera and 2,426 valid species are dealt with. The scope and subfamilies of the Culicidae are those announced in a preliminary note [**47** 17], but only two tribes (Culicini and Sabethini) are recognised in the Culicinae instead of the five there proposed. Information leading to the diagnosis of subgenera and higher categories is omitted, but references relating to the general anatomy, biology and systematics of the family are included, and reference is made to important papers, particularly those containing keys to supraspecific categories, in their appropriate place.

Under each generic or subgeneric name, whether valid or a synonym, the original reference and the type species in its original combination are given and also the name of the selector of the type and the reference to selection if it is a logotype. Data given for each specific and subspecific name are the areas (in most cases the countries) in which the mosquito it represents occurs, the date of and reference to the original description and the stages described, the original taxonomic status where it differs from the one now accepted, the type locality or original localities, and the type depository, together with references to additional information on stages or biology and to nomenclatorial matters wherever a name has undergone a change in status from that given by Edwards. The International Congress of Zoology in London in 1958 adopted a policy for the international rules of zoological nomenclature by which nomenclatorial status will be given to names proposed as varieties before 1959 but not to those proposed as forms, aberrations, etc., which, if subsequently raised to varietal or higher status, have to be credited to the authors first using the new combinations. However, to avoid confusion, infrasubspecific names now treated as varieties, subspecies or species are recognised in this work as dating from their original proposal.

In the main, the names are used in the Catalogue in the same way as they are already used in this *Review*, the chief exceptions being in the classification of the complex of *Anopheles hyrcanus* (Pall.), which is based on that of Reid [**41** 116–118], and of the Palaearctic members of the complex of *A. maculipennis* Mg., which are divided into *A. maculipennis*, with subspecies *melanoon* Hackett (*subalpinus* Hackett & Lewis) and *messeae* Fln., *A. labranchiae* Fln. (*pergusae* Miss. and *sicaulti* Roub.), with subspecies *atroparvus* van Thiel (*fallax* Roub. and *cambournaci* Roub. & Treill.), and *A. sacharovi* Favr. This division of the *maculipennis* complex, which is less complicated than those of previous revisers [**29** 41; **36** 61], will now be adopted in the *Review*, but the *hyrcanus* mosquitos present a special problem for an abstracting journal [*cf.* **41** 117, note] and it is therefore proposed to retain a trinomial nomenclature for identified members of the group, without implying whether the trinomial refers to a subspecies or a sibling species, and to use the term *A. hyrcanus sens. lat.* (instead of the "*hyrcanus*" of Reid) for the group as a whole and for members of it of which the identity is uncertain. The reasons are twofold: first, the lack of adequate study of the identity and status of members of the complex

in the major area of its distribution (Europe, Palaearctic Asia, China and Japan), where the proposed procedure makes it possible to reproduce the various authors' identifications; and second, the help given to readers in following up progressive findings on disease-relations of the complex when its members are brought together in the index instead of being separated as species.

MALLIS (A.). **Handbook of pest control. The behavior, life history, and control of household pests.**—3rd edn., 9¼ × 6 in., 1132 pp., 238 figs., many refs. New York, N.Y., MacNair-Dorland Co., 1960. Price $12.50 in U.S.A.; $13 elsewhere.

The scope and arrangement of this third edition of the author's book on the life-history and control of household pests in the United States, including species that prejudice the health of man, resemble those of the earlier editions [*cf. R.A.E.*, B **42** 147, etc.], but the material has again been brought up to date, especially as regards control.

DANILEVSKIĬ (A. S.). Ed. **The ecology of insects.** [*In Russian.*]—*Uchen. Zap. Leningr. gosud. Univ.* no. 240 (Ser. biol. Nauk no. 46) 160 pp., illus., refs. Leningrad, 1958.

This book includes two papers on the photoperiodic reactions of mosquitos, abstracts of which, based principally on the authors' summaries, appear below.

DANILEVSKIĬ (A. S.) & GLINYANAYA (E. I.). **The dependence of the gonotrophic cycle and imaginal diapause of blood-sucking mosquitos on changes in day length,** pp. 34–51, 1 graph, 9 refs. Laboratory investigations in Leningrad in 1952–53 showed that the main factor regulating the onset of winter diapause in *Culex pipiens pipiens* L. and *Anopheles maculipennis messeae* Flni. is the seasonal change in the period of daylight. The reaction is shown only by females. A short photoperiod (12 hours) causes diapause in females of *C. p. pipiens*, irrespective of temperature and the conditions of larval development. In *A. m. messeae*, however, the reaction is fully shown only by females from larvae that have developed under conditions of short photoperiod, and summer females and those that have developed under long photoperiod in the larval stage react to light conditions only at low temperature. Diapause in both these mosquitos is accompanied by radical changes in feeding and digestion, by cessation of blood-feeding in *Culex* and by gonotrophic dissociation in *Anopheles*. The autumn accumulation of fat results mainly from feeding on carbohydrates and is not a direct indication of diapause. Phenological data are in agreement with the experimental results, and field observations in the Leningrad region showed that the critical daylight period for *A. m. messeae* occurs about 1st August; the critical day-length would probably be shorter further to the south.

VINOGRADOVA (E. B.). **On the photoperiodic reaction in the malaria mosquito,** *Anopheles maculipennis messeae* **Fall.**, pp. 52–60. 3 graphs, 13 refs. The physiological state of females of *Anopheles maculipennis messeae* Flni. is determined by the conditions of photoperiod under which they have developed. A short day (12–15 hours light) induces diapause in all individuals, whereas a long day (20–22 hours light) favours uninterrupted activity. The transition to 100 per cent. diapause in a population is gradual,

the 50 per cent. level being reached when the length of day is 16 hours at a temperature of 23°C. [73·4°F.], but conditions of light do not affect the duration of development or blood-sucking activity. Experiments showed a correlation between the fat content and the state of the gonads of the females. Females that developed under a short photoperiod (14–15 hours light) showed a tendency towards fat accumulation. In *Culex pipiens pipiens* L., the diapause appears as a cessation of blood-sucking and is induced by short day-length, feeding decreasing with day-length to a threshold at 16 hours. In the Anopheline, the physiological state of the females is determined by the conditions of light during the third or fourth larval instar or later. In Leningrad, individuals in diapause appear in the first ten days of August, when the day-length falls to 19–18 hours, and become numerous in the last ten days, when the day-length is 17 hours or less. The critical photoperiod for the occurrence of diapause varies with latitude, becoming shorter from north to south.

Thomson (R. C. Muirhead-). **The malarial infectivity of an African village population to mosquitoes** (*Anopheles gambiae*). **A random xeno-diagnostic survey.**—*Amer. J. trop. Med. Hyg.* **6** no. 6 pp. 971–979, 13 refs. Baltimore, Md., 1957.

The malarial infectivity of African village populations to *Anopheles gambiae* Giles [*cf. R.A.E.*, B **42** 197], with particular reference to *Plasmodium falciparum*, was tested in Liberia by selecting subjects at random, irrespective of their gametocyte rates as revealed by blood films, and feeding batches of laboratory-bred females of the mosquito on them. Malaria, in the area studied, showed both hyper- and holoendemic features [**44** 191]. The degree of infectivity was judged by the number and identity of the oocysts found in the engorged mosquitos after different periods of incubation. Of 347 persons examined in this way at all seasons between December 1955 and November 1956, 32 infected the mosquitos feeding on them, nearly always with *P. falciparum*. All age groups contributed to the infective reservoir, 28 per cent. of the infants and children under about five years old, 12 per cent. of the schoolchildren (about 5–14 years old) and 5·5 per cent. of the adolescents and adults (about 15 years old and over) infecting the mosquitos that fed on them. By taking into account the proportion of these various age groups in the population, it is calculated that, for every 100 individuals in a population of average age composition, 4·2 per cent. of the first age group, 3 per cent. of the second and 3·3 per cent. of the third could infect mosquitos. In most cases, infectivity to mosquitos was low, as few as 3 per cent. of the mosquitos becoming infected and the mean number of oocysts per positive stomach often being only one. There was no indication that unusually high infectivity was necessarily associated with the lower age groups.

Thomson (R. C. Muirhead-). **Notes on the characters of** *P. malariae* **oöcysts of possible value in mixed infections.**—*Amer. J. trop. Med. Hyg.* **6** no. 6 pp. 980–986, 22 figs., 2 refs. Baltimore, Md., 1957.

The following is based on the author's summary. The development and diagnostic features of oocysts of *Plasmodium malariae* in *Anopheles gambiae* Giles were studied in Liberia at a mean temperature of 27–28°C. [80·6–82·4°F.]. Under these conditions, the development of *P. malariae* was

much more rapid than is usually recorded, the cysts being half-grown by the seventh or eighth day instead of by the eleventh day or later. Development was still, however, distinctly slower than that of *P. falciparum* under the same conditions. Wide variations in the size of the oocysts of both species make the size difference of doubtful diagnostic value in individual cases. A characteristic clumping of the pigment in the oocysts of *P. malariae* when the latter were more than half grown, which was described by Shute & Maryon in a paper already noticed [*R.A.E.*, B **45** 201], was confirmed, but forms with two clusters or a bipolar arrangement were frequently seen in addition to the more usual single-cluster form. The diagnostic value of this pigment pattern is limited by the occurrence of atypical oocysts of *P. falciparum* with pigment patterns like those of *P. malariae*. When mixed infections may occur (a possibility even in experimental infections in West Africa) it is usually necessary to confirm the identity of oocysts of *P. malariae* by reference to the developmental picture, their characteristic pigment pattern being conspicuous up to the tenth and eleventh day at least, whereas that of *P. falciparum* seldom persists after the seventh day.

Casals (J.) & Whitman (L.). **Mayaro virus: a new human disease agent. I. Relationship to other arbor viruses.**—*Amer. J. trop. Med. Hyg.* **6** no. 6 pp. 1004–1011, 1 fig., 5 refs. Baltimore, Md., 1957.

Anderson (C. R.), Downs (W. G.), Wattley (G. H.), Ahin (N. W.) & Reese (A. A.). **II. Isolation from blood of patients in Trinidad, B.W.I.**—*T. c.* pp. 1012–1016, 3 refs.

Causey (O. R.) & Maroja (O. M.). **III. Investigation of an epidemic of acute febrile illness on the river Guama in Pará, Brazil, and isolation of Mayaro virus as causative agent.**—*T. c.* pp. 1017–1023, 2 refs.

In the second of these papers, the clinical histories are given of five cases of mild to moderately severe febrile illness of short duration that occurred in Trinidad during August and September 1954 and from which a new virus agent was isolated. Immunological studies with the five strains are described. The agent, to which the name Mayaro virus was given, was pathogenic on intracerebral inoculation into suckling mice, but had no effect on adult mice. Four of the cases were in adult male forest workers in southern Trinidad and one in a negro girl in a town in the north. No mechanism of spread was determined, but as the virus was present in the blood stream, transmission by a biting arthropod seems likely. Whitman found one strain to multiply readily in both *Aëdes aegypti* (L.) and *Anopheles quadrimaculatus* Say after experimental inoculation.

In the first paper, investigations are recorded in which two of the strains of Mayaro virus from Trinidad were compared with a number of previously described arthropod-borne viruses by agglutination, complement-fixation and neutralisation tests. The Mayaro virus was shown to be most closely related to Semliki forest virus [*R.A.E.*, B **34** 87], though sufficiently different from it to justify its being considered distinct.

Six strains of what proved to be the same virus were isolated in 1955 during an investigation, recorded in the third paper, of an epidemic of unknown etiology in a community of quarry and forest workers on the river Guama, 120 miles east of Belém, in the Brazilian State of Pará. There were typical breeding places for *A. darlingi* Root in the locality. Previous neutralisation tests with the Semliki virus had shown protective antibodies in nearly 10 per cent. of over 500 adults from a number of

widely scattered localities in the Amazon valley, and these antibodies probably represent infections with the Mayaro virus.

Lennette (E. H.), Ota (M. I.), Fujimoto (F. Y.), Wiener (A.) & Loomis (E. C.). **Turlock virus: a presumably new arthropod-borne virus. Isolation and identification.**—*Amer. J. trop. Med. Hyg.* **6** no. 6 pp. 1024–1035, 14 refs. Baltimore, Md., 1957.

Lennette (E. H.), Ota (M. I.) & Hoffman (M. N.). **Turlock virus: a description of some of its properties.**—*T. c.* pp. 1036–1046, 3 refs.

An account is given in the first paper of the isolation from mosquitos collected in several areas in the San Joaquin and Sacramento valleys of California of an agent believed to be a hitherto unknown arthropod-borne virus and designated Turlock virus. It was recovered from more than 3 per cent. of 2,785 pools of *Culex tarsalis* Coq. tested in 1954–56, and three strains were also recovered in 1956 from *C. stigmatosoma* Dyar. Infections were found in *C. tarsalis* from June to October, with a maximum in July. After the identification of 46 agents isolated from *C. tarsalis* in 1954 as strains of a single agent, the immune sera prepared against these strains were tested against two agents isolated in previous years but hitherto unidentified. Both isolates were found to be identical with the other 46, and the one from a pool of *C. tarsalis* collected at Turlock in July 1947 was used as a source for the name. The virus is thought to have been present for some time, but only three of the 99 strains showed any pathogenicity for adult mice and it was not detected until chick embryos were included in routine tests of field materials for encephalitis infection. The Turlock virus has also been isolated from a wild finch and from chicks exposed during an investigation of encephalitis. The part it plays, if any, in causing human or animal disease is not known, but information so far available suggests that human infection is not common, and there is no evidence that it is etiologically involved in human encephalitis.

The observations described in the second paper showed that Turlock virus is highly pathogenic for chick embryos and less so for day-old chicks, and also that suckling mice are very susceptible to it, whereas adult mice are highly resistant. Guineapigs and rabbits appear to be resistant to infection but produce relatively high levels of neutralising antibody.

Chamberlain (R. W.), Sikes (R. K.) & Sudia (W. D.). **Attempted laboratory infection of bird mites with the virus of St. Louis encephalitis.**—*Amer. J. trop. Med. Hyg.* **6** no. 6 pp. 1047–1053, 15 refs. Baltimore, Md., 1957.

The following is virtually the authors' summary. Laboratory studies were carried out in Alabama in attempts to infect three common species of bird mites, *Dermanyssus gallinae* (Deg.), *Ornithonyssus bursa* (Berl.) and *O. sylviarum* (C. & F.), with the virus of St. Louis encephalitis and to transmit infection by the bite of these mites to newly hatched chicks [*cf. R.A.E.*, B **33** 25, 178]. The virus tests were carried out on white Swiss mice three weeks old that were inoculated intracerebrally. Detectable virus persisted for less than two days in the mites, and no transmissions by bite were shown. These negative results support those previously reported by Reeves and others [**44** 161] and indicate the lack of importance of bird mites in transmission of infection with St. Louis encephalitis.

Murray (K. F.). **An ecological appraisal of host-ectoparasite relationships in a zone of epizootic plague in central California.**—*Amer. J. trop. Med. Hyg.* **6** no. 6 pp. 1068–1086, 1 map, 8 refs. Baltimore, Md., 1957.

The following is largely based on the author's summary. In 1953, an epizootic of plague occurred in the San Bruno Mountains, in western California, which are enclosed on three sides by urban and agricultural development. A survey of small mammals and their ectoparasites was therefore undertaken in the district in the spring of 1954. Trapping was carried out in 25 designated areas, lines of 25 or 50 snap traps being used. In all, 964 mammals of ten species were collected, and their relations to the principal vegetation types of the area are described. *Peromyscus maniculatus* was the most abundant and widespread. *Reithrodontomys megalotis* occurred infrequently and was more abundant where the numbers of *P. maniculatus* were low. The overall population of *Microtus californicus* was low, and colonies were scattered, but one of the few extensive areas with large colonies coincided with an apparent focus of the plague epizootic. Other species taken included *P. californicus*, *Mus musculus*, *Thomomys bottae*, *Rattus norvegicus* and two species of *Sorex*. *R. norvegicus* was plentiful on two pig farms.

The fleas found on the mammals numbered 1,364 and belonged to 15 species. *Opisodasys kecni nesiotus* Augustson predominated on *P. maniculatus*. *Malareus telchinum* (Roths.) was predominant on *Microtus* but was also abundant on *P. maniculatus* and was generally the most widespread species. *Catallagia wymani* (Fox) occurred frequently on *P. maniculatus* and *Microtus*. An undescribed species of *Hystrichopsylla* and *Atyphloceras multidentatus* (Fox) were important primarily in nests of *Microtus* and probably in those of *P. maniculatus*. *R. norvegicus* trapped from pig farms bore almost entirely *Nosopsyllus fasciatus* (Bosc). Habitat had no apparent effect on infestation of *P. maniculatus* by fleas. The host specificity of the more abundant species was low, but *Opisodasys* was clearly associated with *Peromyscus* and *Reithrodontomys*, and its occurrences on *Microtus* may result from contact with these species. *Microtus* is considered a key species in promoting flea exchange [*cf. R.A.E.*, B **47** 159; **48** 32], possibly because its runways are often used by other mice and shrews, and it, in its turn, uses burrows of gophers (*Thomomys*).

Plague was first isolated from two pooled examples of *Opisodasys* from an individual of *Reithrodontomys* collected in the Rivera Canyon. As a result, 5,000 lb. of oat groats that had been treated with 1 per cent. zinc phosphide was distributed by air over about 500 acres in the canyon and in adjacent areas, and an additional 1,000 lb. by hand in inaccessible and critical situations. Trapping indicated reductions of 25–80 per cent. in the wild rodent population in four different areas, *Microtus* being most severely affected, but populations generally regained their previous levels in about two months, and *Reithrodontomys* showed a striking and unexplained increase. The average number of fleas per host and the percentage of hosts bearing fleas increased sharply immediately after poisoning, which was apparently ineffective in reducing the plague transmission potential among the wild rodents. In the first resurvey that followed the distribution of poison bait, plague was again isolated, from a pool of eight examples of *Malareus* from two individuals of *Microtus* collected a little to the south-east of the canyon; this, with the finding of fleas infected with plague from other sites in the same areas, suggested that the epizootic was essentially limited to the south-western end of the San Bruno Mountains. Rats were successfully controlled on the pig farms and in suburban areas, and a zone of possible transfer of plague from wild mammals to man was thus cleared.

Attention is drawn to the part played by habitat distribution in governing inter-specific host and flea contacts, continuity of distribution of host populations and opportunity for contact between native mammals, on the one hand, and man and domestic rats, on the other.

SHEPARD (H. H.). Ed. **Methods of testing chemicals on insects. Volume II.**—$8\frac{3}{4} \times 5\frac{3}{4}$ in., [4+] iii + 248 pp., 16 figs., 27 pp. refs. Minneapolis, Minn., Burgess Publ. Co., 1960. Price £2 or $5.

This second volume of a series [*cf. R.A.E.*, B **46** 221] is devoted mainly to discussions of factors affecting the results of experiments with insecticides and preliminary testing. The reviews, all of which are noticed elsewhere [A **48** 198], include **Pre-test conditions which affect insect reaction to insecticides,** by Yun-pei SUN (pp. 1–9, 1 graph); **Factors affecting insects during exposure to insecticides,** by J. C. GAINES & W. J. MISTRIC jr. (pp. 10–18); **Post-exposure conditions and determination of end-point,** by R. L. BEARD (pp. 19–27); **Exposure to treated food medium,** by A. W. A. BROWN (pp. 28–33); **Screening space sprays against flies and cockroaches,** by R. H. NELSON (pp. 34–46), in which the principal fly concerned is *Musca domestica* L.; **Screening chemical repellents,** by P. GRANETT & E. B. STARNES (pp. 101–119); **Screening chemical attractants,** by J. T. MEDLER (pp. 131–155); **Animal sprays, dusts, dips, and dressings,** by R. C. BUSHLAND (pp. 193–199); and **Techniques for evaluating systemic insecticides against livestock insects,** by O. H. GRAHAM (pp. 200–216, 5 figs.).

RODRIGUEZ jr. (J. L.) & RIEHL (L. A.). **Spot treatments with malathion dust for control of the northern fowl mite on hens in individual wire cages.**—*J. econ. Ent.* **52** no. 1 pp. 13–14, 1 ref. Menasha, Wis., 1959.

Ornithonyssus sylviarum (C. & F.) is a common and recurrent pest of fowls housed in individual wire-mesh cages (containing one or two hens per compartment) in southern California. On three habitually infested ranches, control was achieved in 1957–58 by a programme of spot treatments in which 4 per cent. malathion dust [*cf. R.A.E.*, B **43** 159; **45** 114] was applied to the vent area of the hen or hens in any cage found by daily examination of eggs for mites to be infested, and in the three adjacent cages on both sides of the infested cage in the same row. In the first week, 21·4, 8·2 and 0·9 per cent. of the cages needed treatment on the three ranches, respectively, and the numbers of mites on infested fowls were large. The percentages of cages needing treatment during the following 51 weeks totalled 30·8, 13·1 and 9·2, respectively; no cage needed treatment on more than one occasion, and the number of mites on infested birds was relatively low. The amount of insecticide and labour used in the spot treatments for the year was much less than that needed for a single application to the whole ranch, and formerly with complete treatment infestations had recurred several times a year.

METCALF (R. L.), FUKUTO (T. R.) & MARCH (R. B.). **Toxic action of Dipterex and DDVP to the house fly.**—*J. econ. Ent.* **52** no. 1 pp. 44–49, 4 graphs, 17 refs. Menasha, Wis., 1959.

Trichlorphon (dimethyl 2,2,2-trichloro-1-hydroxyethylphosphonate) is rapidly degraded to dichlorvos (dimethyl 2,2-dichlorovinyl phosphate) under

mildly alkaline conditions. Using ^{32}P-labelled material, the authors found that 50 per cent. degradation was effected in just over 1, about 6·4 and 89 hours at pH values of 8, 7 and 6, respectively, and that the rate of the reaction at pH 5·4 was very slow indeed. Dichlorvos is itself hydrolysed to dimethyl phosphoric acid, but the process is a slower one. As dichlorvos is very toxic to house-flies (*Musca domestica* L.) [*cf. R.A.E.*, B **47** 132], the possibility that it might be involved in the action of trichlorphon on them was investigated. In *in vitro* tests, dichlorvos proved a more powerful inhibitor of fly-brain cholinesterase than trichlorphon. Inhibition by 10^{-7} M trichlorphon showed marked dependence on pH and ranged from 11 per cent. at pH 5·4 to 100 per cent. at pH 8, but inhibition by 10^{-8} M dichlorvos was complete throughout this range. This, in conjunction with the fairly rapid conversion of trichlorphon to dichlorvos at pH 7 and pH 8 and the greater chemical suitability of the latter for reaction with cholinesterase, is considered to indicate that the *in vitro* anticholinesterase activity of purified trichlorphon at pH 7·4–7·6, the range commonly used in manometric or electrometric assay, is a result of the formation of dichlorvos. When flies were fed on sugar and trichlorphon moistened with buffer solutions of pH 8·6 or 5·4, on filter paper, 50 per cent. were knocked down in one minute by the first, but only after 15–20 minutes by the second. This, as well as the isolation of about 5 per cent. of ^{32}P dichlorvos from the total ^{32}P metabolites in trichlorphon-poisoned flies and the fact that dichlorvos was 4–7 times as toxic as trichlorphon when administered in different ways, strongly indicates that dichlorvos is responsible for the *in vivo* toxic action of trichlorphon.

Experiments in which flies were exposed on a disk impregnated with trichlorphon and sugar showed that when the labellum was cut off knock-down took about 12 times as long, on an average, as it did with intact flies, thus demonstrating that the major toxic action was exerted through the labellum.

Morrison (F. O.) & Hagley (E. A.). **The effect of three p-chlorophenyl compounds on the biology of the house fly.**—*J. econ. Ent.* **52** no. 1 pp. 61–62, 9 refs. Menasha, Wis., 1959.

Several chemicals synergistic with pyrethrum have been shown to inhibit the development of *Musca domestica* L. when incorporated into a standard rearing medium [*R.A.E.*, B **45** 177–178, etc.], and inhibition of oviposition following exposure of females to contact with several p-chlorophenyl compounds has been reported [**47** 66]. An account is here given of studies in which di(p-chlorophenyl)chloromethane, di(p-chlorophenyl)-methyl-carbinol (DMC) and di(p-chlorophenyl)-ethynyl-carbinol, which have a synergistic action with DDT used as a contact insecticide against adults of *M. domestica* L. [**47** 83], were added in benzene at 1·3, 13 and 130 parts per million (w/v) to the milk used to moisten the substrate in which the larvae were being reared, to determine their possible effect on development. There was some mortality in the early instars, but larvae that survived grew at the normal speed, reached normal weight, showed no impairment of vigour or activity and gave rise to normal pupae and adults. The surviving third-instar larvae, but not the pupae and adults, were more susceptible to contact with DDT than were those from untreated media. The rate of pupation was slowed down by all materials, particularly at the higher concentrations. The length of life of the resulting adults was not affected by any of the materials at the highest concentration, the viability of their eggs was not affected by any of them at 13 p.p.m., and the number

laid was not affected by any at 1·3 p.p.m., except that it was just significantly increased by the chloromethane; results for the other concentrations are not given.

Hermenze (F.) & Goodwin (W. J.). **Normal cholinesterase activity in the erythrocytes of cattle.**—*J. econ. Ent.* **52** no. 1 pp. 66–68, 2 refs. Menasha, Wis., 1959.

As several organophosphorus insecticides show promise for the control of ectoparasites of domestic animals, and the degree of inhibition of cholinesterase activity is one of the chief means of determining their effects on the host, the normal value of blood cholinesterase activity must be established for each species on which toxicological tests are likely to be made. An account is given of an investigation of the normal activity in the erythrocytes of cattle of four breeds and various ages. The mean difference in pH readings of blood samples taken before and one hour after addition of acetylcholine chloride was 0·422 for the 14 groups tested, and no significant difference was noted between beef and dairy cattle or between animals of different ages; there was more variation between individuals than between breeds. Variations in ambient temperature appeared to have no effect on cholinesterase activity.

Dow (R. P.) & Willis (M. J.). **Evaluation of insecticides for the control of *Hippelates pusio* in soil.**—*J. econ. Ent.* **52** no. 1 pp. 68–71, 1 fig., 5 refs. Menasha, Wis., 1959.

In plot tests in south-western Georgia in 1951–52 on the control of *Hippelates pusio* Lw., the soil of breeding areas was treated with chlorinated-hydrocarbon insecticides; emulsion sprays of aldrin at 0·5–2 lb., chlordane at 1–4 lb. and DDT at 4–16 lb. per acre were applied to small plots that had previously been disked, ploughed and disked again, and one of BHC at 2·5 lb. γ isomer per acre to a larger, undisturbed plot with flattened grass cover. All plots were disked after treatment to encourage oviposition, and emergence traps were installed in them 3–10 days later. Collections at intervals of three days showed that aldrin at 1 or 2 lb., chlordane at 4 lb. and BHC gave excellent control, an average of less than 0·1 adult per sq. ft. being trapped over the plot in each case, as compared with 2·24–4·97 over untreated control plots. Disking the soil again 41 days after the BHC treatment, when collections from the untreated plot had fallen very low, demonstrated the continued effectiveness of the original application against a second generation. DDT had little or no effect even at 16 lb. per acre.

To evaluate soil insecticides for the control of *H. pusio*, it is desirable to have traps in position one week before the peak of emergence, and this necessitates consideration of soil temperature. When afternoon soil temperatures at a depth of 6 in. averaged 83 and 78°F., the development of *H. pusio* from oviposition to the peak of adult emergence required periods of about 21 and 26 days, respectively. The traps used had wooden sides and a flat white canvas top into which two inverted collecting jars with funnels were inserted. The numbers of adults taken in them over untreated soil were very variable, apparently owing to the activities of scavengers and predators, including ants. Treating the interior of the jars with dieldrin, to kill the insects and so prevent their escape at night, had no effect on the recovery of introduced individuals, which was low, but further work indicated that they were probably removed by the ants before reaching

the jars. Better results might be achieved by the use of ant barriers and by the substitution of opaque black cloth for the white canvas covers, to take full advantage of the phototropism of *H. pusio*.

Gojmerac (W. L.), Dicke (R. J.) & Allen (N. N.). **Factors affecting the biology of cattle lice.**—*J. econ. Ent.* **52** no. 1 pp. 79–82, 2 figs., 8 refs. Menasha, Wis., 1959.

Populations of *Damalinia* (*Bovicola*) *bovis* (L.) were intensively studied in Wisconsin from November 1957 to the spring of 1958 on 12 heifers representing four dairy breeds. Weekly counts in five sites on each animal showed that the occurrence of the louse was cyclic with infestations reaching a peak in late January or early February and disappearing by 1st May. Numbers found on six Holstein heifers ranged from 228 to 738, whereas 10 and 53 were found on two Guernseys, 2 and 4 on two Jerseys and 12 and 45 on two of the Brown Swiss breed. These differences could not be associated with any differences in diet, since all animals were given a uniform ration, or with the skin secretions or hair cover of the different breeds, which were shown not to differ in the range of the diameters or lengths of individual hairs or in the density of hair per unit area of skin surface. There was, however, a significant difference between the diameters of the hairs of the individual Holstein heifers, and a significant positive correlation between these diameters and the size of the louse populations. It was also demonstrated that the amount of skin scurf was greater during the summer months than during the winter months, when populations are high. No lice were found in monthly examinations of cattle during the spring and summer of 1954.

Gersdorff (W. A.) & Piquett (P. G.). **Toxicity of the piperonyl ester of chrysanthemumic acid and some of its derivatives in comparison with allethrin and pyrethrins as house fly sprays.**—*J. econ. Ent.* **52** no. 1 pp. 85–88, 8 refs. Menasha, Wis., 1959.

The following is substantially the authors' summary. Tests were made of 18 related synthetic compounds, most of them substituted piperonyl esters of *dl-cis-trans*-chrysanthemic acid, as kerosene-base space sprays on the Campbell turntable [*R.A.E.*, B **26** 246] against *Musca domestica* L. The most toxic were the 6-bromopiperonyl ester and the 6-chloropiperonyl ester (barthrin), which were, respectively, about 21 and 31 per cent. as toxic as allethrin and 51 and 83 per cent. as toxic as pyrethrins at the 50 per cent. mortality level. Above this level, the ratios were higher, reaching about 25 and 50 per cent., respectively, in relation to allethrin and 90 and 200 per cent. in relation to pyrethrins at the 95 per cent. mortality level. The knockdown given by these esters was practically complete at the highly toxic concentrations but was much inferior to that of allethrin or pyrethrins at lower comparable concentrations.

Roth (A. R.) & Eddy (G. W.). **Tests with a new organophosphorus compound (Dowco 109) against cattle grubs in Oregon.**—*J. econ. Ent.* **52** no. 1 pp. 169–170, 3 refs. Menasha, Wis., 1959.

In tests with O-methyl O-(4-tert.-butyl-2-chlorophenyl) methylphosphoramidothioate (Dowco 109) as a systemic insecticide for the control of *Hypoderma* in cattle in Oregon, animals were treated in the autumn, before

the larvae appeared, and examined for them in February, March and April or May, when *H. lineatum* (Vill.), *H. bovis* (Deg.) or both were present according to the season. The percentage control given by application in boluses or capsules at 4–15 and 20–25 mg. per kg. was 67–100 and 94–100 per cent., respectively. A 0·75 per cent. spray applied at a pressure of 250–300 lb. and a rate of 2 or 4 U.S. quarts per animal gave 71–100 or 99–100 per cent. One yearling steer was treated orally with 25 mg. per kg. when it already had 22 encysted second- and third-instar larvae. Dead larvae were noted on the third day, and all were dead after 14 days. It is concluded that Dowco 109 has the advantage of versatility as it appears to be as effective as Bayer 21/199 [O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl phosphorothioate] when the toxicants are applied as sprays and as Dow ET-57 [purified O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate] when treatment is oral [*cf. R.A.E.*, B **48** 16–17, 56].

Kraemer (P.) & Furman (D. P.). **Systemic activity of Sevin in control of *Ornithonyssus sylviarum* (C. & F.).**—*J. econ. Ent.* **52** no. 1 pp. 170–171. Menasha, Wis., 1959.

The systemic activity of Sevin against *Ornithonyssus sylviarum* (C. & F.) on hens was investigated in preliminary tests in California in which a wettable powder was thoroughly mixed with the mash to give a feed containing 0·3 per cent. actual Sevin. In a laboratory screening test, a heavily infested hen that ingested a total of 1,225 mg. technical Sevin per kg. body weight, over a period of five days, became completely free of mites on the second day after treatment began. In three subsequent field tests, in which the hens were continuously exposed to reinfestation from adjacently caged birds, two moderately infested hens that received 740 mg. per kg. over a period of four days, five moderately to heavily infested hens that received 175 mg. per kg. on one day and two heavily infested ones that ingested 270 mg. per kg. in two days and four that ingested 140 mg. per kg. on one day were free of mites on the second day after treatment began and remained so at a second examination 3–19 days later. Four heavily infested hens that ingested 68 mg. per kg. on one day, from a feed containing only 0·15 per cent. Sevin, were uninfested or very lightly infested five days later. There was no decrease in infestation on untreated control birds. Of five moderately infested hens that received an average of 78 mg. Sevin per kg. on one day, one had a light infestation 40 hours later, two had very light infestations and two were free of mites. They were then given another ration of the same feed and ingested amounts equivalent to 150 mg. Sevin per kg., and all were free of mites three days later. No recurrence was noted within ten days. No ill effects were observed in five hens that consumed 920 mg. technical Sevin per kg. body weight over a period of eight days or in the one that consumed 1,225 mg. per kg. in five days. No mortality or ill effects occurred among 40 individuals from a laboratory colony of *Cimex columbarius* Jenyns that fed for three days on hens the diet of which contained 0·3 per cent. actual Sevin.

LaBrecque (G. C.), Wilson (H. G.) & Smith (C. N.). **Effectiveness of two carbamates against DDT- and malathion-resistant house flies.**—*J. econ. Ent.* **52** no. 1 pp. 178–179. Menasha, Wis., 1959.

In tests of the extent of cross-resistance to carbamates in *Musca domestica* L., 4-methyl-2-propylpyrimidinyl N,N-dimethylcarbamate,

Pyrolan (1-phenyl-3-methyl-5-pyrazolyl dimethylcarbamate), malathion and DDT were applied topically in acetone to females of a strain (Grothe) highly resistant to malathion and moderately resistant to DDT, a strain (No. 1) completely resistant to DDT and slightly resistant to malathion, and the regular colony. Application was at 0·1 μl. per 2 mg. body weight, and concentrations were varied to give a range of mortality after 24 hours. Pyrolan was less effective than DDT or malathion against the flies of the regular colony, but the other carbamate was more effective. Resistance in the flies of the Grothe strain was about 400-fold to malathion, 40-fold to DDT and 10-fold or less to the carbamates, as compared with the regular colony. The flies of No. 1 strain showed complete resistance to DDT, and slight resistance to the carbamates of the same order as that shown to malathion. The results suggest that the carbamates might not be effective in some areas and might not long remain so in others.

Bradbury (F. R.) & Standen (H.). **The fate of γ-benzene hexachloride in resistant and susceptible houseflies. III.**—*J. Sci. Fd Agric.* **9** no. 4 pp. 203–212, 17 refs. London, 1958.

In the previous papers of this series [*R.A.E.*, B **45** 30, etc.], it was shown that a strain of house-flies [*Musca domestica* L.] resistant to γ BHC (the Uruguayan strain [*cf.* **44** 111–112]) rapidly and extensively converted γ BHC to water-soluble compounds, which were excreted. This was shown by partition of the radioactive matter in flies treated with ^{14}C-labelled γ BHC between water and carbon tetrachloride, the carbon-tetrachloride fraction apparently consisting mainly of unchanged γ BHC. TCB (trichlorobenzene) was sought but, with radioactive BHC of the specific activity then available, was not found [**43** 187–188]. The publication of evidence that the first step in the metabolism of γ BHC in house-flies is the formation of the monodehydrochlorination product PCH (pentachlorocyclohexene) [**45** 145] necessitated re-examination of the radioactive matter in the carbon-tetrachloride fractions by more refined analytical processes and with γ BHC of high specific activity.

In experiments here described in detail, both a chemical process of low specificity but high sensitivity and an isotopic-dilution method [*cf.* **48** 86] of higher specificity but lower sensitivity were used. In the first process, an acidic constituent was removed from the carbon-tetrachloride fraction by extraction with a solution of sodium hydroxide, and PCH, TCB and γ BHC were separately estimated by application of radiochemical analysis to the process used in the colorimetric determination of BHC described by Armstrong, Bradbury & Standen [A **40** 37]. Unchanged γ BHC was the major constituent of the carbon-tetrachloride extracts, whatever the condition of the exposure or the dosage used (0·1–4·4 μg. per fly). PCH formed 2–3 per cent. of the absorbed dose in resistant flies stored for one hour after exposure for 15 minutes to saturated vapour of γ BHC, but a much smaller proportion (0·1–1 per cent.) if storage was for a longer period or exposure to BHC was continued for 24 hours. It is concluded that if this compound is an intermediate in the metabolism of γ BHC by resistant house-flies, it has, in the Uruguayan strain, only a very transient existence. TCB represented less than 2 per cent. of the total γ BHC absorbed, an amount insufficient for detection when γ BHC of much lower specific activity was used. The phenolic or acidic constituents comprised up to 2·5 per cent. of the BHC absorbed. The radioactive γ BHC used in earlier experiments also contained a small amount of the β isomer, which accumulated in the carbon-tetrachloride extracts to the extent of 3–4 per cent. of the original dose as metabolism of γ BHC proceeded.

As TCB, PCH, acidic substances and β BHC, amounting together to about 10 per cent. of the original dose of γ BHC, appear in the carbon-tetrachloride extracts, it is incorrect to equate the radioactive matter soluble in carbon tetrachloride with unchanged γ BHC as was done in the earlier investigation [*cf.* B **43** 187–188]. The correction increases in significance as metabolism proceeds and implies, for example, that three hours after an exposure of 15 minutes to γ BHC, the toxic compound has virtually disappeared from the resistant flies, whereas it is still present in the susceptible flies 24 hours after exposure [*cf.* **45** 30]. The advantage conferred on the resistant strain by its increased powers of detoxification is thus greater than had previously been supposed, but the difference in gross rates of conversion of γ BHC to metabolite is still insufficient in itself to account for the greater tolerance of the resistant strain.

In the work of Sternburg & Kearns [**45** 145], resistant flies produced much more PCH than in the present work. Possible reasons for this include differences in the methods of application of the γ BHC (topical application instead of exposure to vapour) and in analytical methods and fly strain. The Uruguayan strain may have a detoxification mechanism differing from that of the flies used by Sternburg & Kearns. The latter, which build up PCH and convert it relatively slowly to water-soluble products, appear to dispose of γ BHC by an enzyme process similar to that used by DDT-resistant strains in which the monodehydrochlorination product, DDE, is first formed and water-soluble products are produced relatively slowly. By contrast, the Uruguayan strain rapidly converts γ BHC to water-soluble products, PCH either being formed in very small amounts or being further metabolised almost immediately.

The fate of α BHC in the Uruguayan strain must also be taken into account in considering the possible intermediate part played by PCH. It has been shown that the compounds produced by breakdown of the α and γ isomers of BHC in resistant flies of the Uruguayan strain are very similar, and it is probable that the same metabolic process is used for both. Whereas the intermediate monodehydrochlorination product of either γ or δ BHC can be isolated *in vitro*, that of α BHC is so rapidly attacked by alkaline reagents that the reaction goes right through to trichlorobenzenes before the intermediate stage can be recovered. Whilst the limitations of *in vitro* processes may not apply to enzyme reactions in the fly, it seems likely that a metabolic process that starts with dehydrochlorination would produce different end-products in the case of α BHC where the postulated intermediate, PCH, appears to be very labile under dehydrochlorinating conditions. In this case, TCB and its derivatives might be expected amongst the metabolic products, but carbon-tetrachloride extracts of flies of the Uruguayan strain treated with α BHC consist mainly of the unchanged isomer.

The proposition that PCH is an intermediate in the metabolism of BHC by the Uruguayan flies is therefore treated with some reserve, and it is preferable to regard it and the accompanying small amount of TCB as the results of a secondary dehydrochlorination process.

Beckel (W. E.). **Investigations of permeability, diapause, and hatching in the eggs of the mosquito *Aëdes hexodontus* Dyar.**—*Canad. J. Zool.* **36** no. 4 pp. 541–554, 1 fig., 29 refs. Ottawa, 1958.

Aëdes hexodontus Dyar overwinters in the egg stage, during which it appears to undergo an obligate diapause, since eggs laid in the laboratory during summer do not hatch if kept at room temperatures, even though

embryonic development is complete. As little is known of the physiological properties of the eggs of most mosquito species, and especially of those common in northern Canada, the changes in the permeability of the egg to water during pre-diapause development and the factors affecting diapause were investigated in the laboratory. For this purpose, many thousands of eggs were obtained, by methods that are described, from blood-fed females collected in the field in northern Manitoba; fertile eggs could be distinguished from infertile ones because, though both are white when laid, the fertile eggs begin to darken within half an hour unless the ovum or early embryo is dead. The following is largely based on the author's summary of the results. Two changes in permeability in the pre-diapause stage of the eggs were observed. The eggs, when first laid, were readily permeable to water, but became less so as the chorion darkened, though complete waterproofing did not result. With the formation of the transparent cuticle, the egg lost hardly any water even when exposed to extreme desiccation and the little water lost was regained very slowly. The cuticle, when the chorion was removed by sodium hypochlorite, was quite permeable. The impermeability of the chorion and cuticle combination must therefore result from the bonding between the two.

The obligate diapause that occurs in the late embryogeny of the mosquito egg was not broken when water was made available to the embryo, or by alternate periods of light and darkness at room temperature, but eggs sometimes hatched at lower temperatures. To test the influence of cold, eggs were exposed to temperatures of 1 and −3°C. [33·8 and 26·6°F.] for 200 days to simulate the winter in the field. The low temperatures sometimes terminated diapause, but the numbers of eggs hatching did not steadily increase with an increase in the time of exposure to cold, and it was concluded that diapause could be broken by cold, but that other unknown factors are involved. More eggs hatched in an infusion of decaying adult mosquito bodies in distilled water than in distilled water alone.

Papers noticed by Title only.

Lewis (D. J.) & Garnham (P. C. C.). **The species of** *Phlebotomus* **(Diptera: Psychodidae) in British Honduras.**—*Proc. R. ent. Soc. Lond.* (B) **28** pt. 5–6 pp. 79–89, 50 figs., 19 refs. London, 1959.

Doss (M. A.), Humphrey (J. M.) & Segal (D. B.). **Index-catalogue of medical and veterinary zoology. Supplement 9. Authors: A to Z.**—[1+] 322 pp. Washington, D.C., U.S. Dep. Agric., 1959. Price $1.25 (from Supt. Documents). [*Cf. R.A.E.*, B **47** 208.]

Arthur (B. W.) & Casida (J. E.). **Biological activity and metabolism of Hercules AC-528** [2,3-p-dioxane S,S-bis(O,O-diethyl phosphorodithioate)] **components in rats and cockroaches** [*Periplaneta americana* (L.)].—*J. econ. Ent.* **52** no. 1 pp. 20–27, 3 figs., 15 refs. Menasha, Wis., 1959. [*Cf. R.A.E.*, A **48** 215.]

Pryor (W. J.) & Skerman (K. D.). **Prevention of breech strike in Merino ewes by plunge dipping in dieldrin and diazinon.**—*Aust. vet. J.* **35** no. 1 pp. 13–15, 3 refs. Sydney, 1959.

The possibility of protecting sheep against breech strike by blowflies through treatment in dips charged with arsenic, dieldrin or diazinon was investigated in western Victoria in 1956–57. An aqueous concentrate containing 29·8 per cent. arsenic trioxide, a wettable powder containing 50 per cent. dieldrin and an emulsifiable concentrate containing 25 per cent. diazinon were used, and the sheep were Merino ewes 3–5 years old. In comparative tests, 1·2 per cent. of 401 ewes dipped in 0·02 per cent. diazinon and 8·4 per cent. of 405 dipped in arsenic (0·13 per cent. As_2O_3) received breech strikes in 17 weeks, and the difference was highly significant, but when 592 ewes were dipped in 0·01 per cent. diazinon and 594 in 0·025 per cent. dieldrin the percentages similarly struck were 3·4 and 3·8, respectively, and the difference was not significant. There were no body strikes. Breech strikes showed little tendency to spread, except on the sheep dipped in arsenic. It is concluded that dipping is of value in the prevention of strike, and as dipping soon after shearing for the control of lice and keds [*Melophagus ovinus* (L.)] is compulsory in Victoria and usual in other parts of Australia, it is suggested that, where the time of shearing allows dipping just before the fly season, an insecticide of recognised value for preventing fly-strike could be used. Jetting should be used if any further treatment is needed to give late-season protection.

Browne (L. B.). **The relation between ovarian development and mating in *Lucilia cuprina*.**—*Aust. J. Sci.* **20** no. 8 p. 239, 2 refs. Sydney, 1958.

Following observations in Australia that about 85 per cent. of females of *Lucilia cuprina* (Wied.) mated by the end of the third day when the adults had been supplied with liver from the time of emergence, whereas none mated for five days and only about 10 per cent. by the eighth day when only sugar and water were provided, the effect of protein [*cf. R.A.E.*, B **48** 30] on the willingness or ability of both sexes to mate was investigated. Males and females four days old that had been supplied with liver or with sugar and water only were caged together for an hour. A mean of 6 out of 8 protein-fed females per cage mated, whether the males were protein-fed or not, whereas a mean of 2 out of 8 females per cage that received no protein mated with males that had had liver and 1·5 per cage with males that had not. In an experiment with examples of a strain in which the ovaries of some females develop fully without protein, six groups of nine males and nine females were caged together for one hour when six days old. On examination, none of the females had completely undeveloped ovaries, and 24 per cent. of those with ovaries in the second and third stages in P. M. Harlow's classification and 69 per cent. of those in the last two stages had mated. It is concluded that the state of the ovaries is important in determining whether females will mate.

Riek (R. F.). **Studies on the reactions of animals to infestation with ticks. III. The reactions of laboratory animals to repeated sublethal doses of egg extracts of *Haemaphysalis bispinosa* Neumann.**—*Aust. J. agric. Res.* **9** no. 6 pp. 830–841, 2 pls., 20 refs. Melbourne, 1958.

The following is virtually the author's summary of this third part of a series [*cf. R.A.E.*, B **47** 87]. Rabbits and mice were immunised or

sensitised, and guineapigs sensitised, with saline extracts of the eggs of *Haemaphysalis bispinosa* Neum. Immunisation, without sensitisation, invariably followed intravenous inoculation of the antigen once or twice per week for three weeks. Sensitisation, with or without development of precipitating antibody, usually followed daily inoculation for 3–5 days, subcutaneous administration possibly being more effective than intravenous. Development of sensitisation was capricious. Immunised animals were protected against the toxic egg extracts, but not against attachment of larval ticks. Their sera contained complement-fixing and precipitating antibody, which was not destroyed at 56°C. [132·8°F.] for four hours. Sensitising antibody could not be demonstrated in these sera by direct skin test or passive transfer. Sensitised animals responded to intradermal injection of antigen by a characteristic skin reaction, and were protected against effective attachment of larval ticks. Sensitisation could be transferred passively by subcutaneous inoculation of serum and was not reduced by absorbing out any precipitating antibody that may have been present. The sensitising antibody was destroyed by heating to 56°C. for four hours. In passive transfer tests, sera of immunised animals blocked local reaction to antigen in sensitised animals, but the blocking antibody rapidly diffused from the site, whereas sensitising antibody remained fixed. Electrophoretic evidence suggests that the immune antibodies are principally γ-globulins, whereas the sensitising antibodies are mainly β-globulins.

Milner (K. C.), Jellison (W. L.) & Smith (B.). **The role of lice in transmission of** *Salmonella*.—*J. infect. Dis.* **101** pp. 181–192, 27 refs. Chicago, Ill., 1957.

During epidemics of relapsing-fever transmitted by lice, *Pediculus humanus humanus* L. (*P. h. corporis* Deg.), in Russia after the first world war, mixed relapsing-fever and paratyphoid infections, attended by very high mortality, were frequent. It was suggested that the malignant form of paratyphoid infection, which occurred only in association with relapsing fever, might be transmitted by the same lice. Bacteriological studies showed that at least two types of *Salmonella*, related to *S. paratyphi* and *S. enteritidis*, respectively, were involved. Later, an association between relapsing fever and infection with *S. enteritidis* was observed in China and Korea. The possibility that under some conditions salmonellosis might be louse-borne was investigated in the United States with body lice maintained on rabbits and also fed experimentally through membranes of fresh chick skin [*cf. R.A.E.*, B **40** 16]. Lice ingesting only one viable unit of *S. enteritidis* (as determined by plate counts) developed heavy infections that proved fatal in 48 hours or much less. The average volume of blood ingested was 1 μl., so that it would appear that a density of 1,000 organisms per ml. would prove infective. The bacteria multiplied logarithmically in the lice throughout the 2–6 hours after the introduction of an infective dose, and reached their maximum titre in 6–8 hours. Cultures of several other species of *Salmonella*, including *S. typhi* isolated from a patient with typhoid fever, infected lice, though not all were so rapidly lethal. Lice each contained about ten million viable *Salmonella* organisms at death. Freshly passed faeces of lice infected with *S. enteritidis* contained about a million viable units per mg. *S. enteritidis* and *S. typhi* survived in considerable numbers in dead lice and louse faeces for more than a year, and the former sometimes survived for four years. *Shigella dysenteriae* was weakly pathogenic, though able to survive and multiply in the lice.

One passage of *S. enteritidis* through lice did not materially alter virulence

for mice. Relapsing-fever spirochaetes (*Borrelia* [*crocidurae*]) derived from the small form of *Ornithodoros erraticus* (Lucas) collected in Egypt [**44** 108–109] and inoculated parenterally did not increase the virulence of *S. enteritidis* for mice when the latter was introduced by mouth, but when both agents were introduced together by the parenteral route, the presence of *Borrelia* appeared to increase virulence. Lice failed to transmit *Salmonella* to normal rabbits by feeding, though fatal infection followed parenteral injection of suspensions of the same lice. Suckling mice that had been bitten by infected lice became infected, but had probably acquired the disease indirectly through the louse faeces. Membrane-feeding experiments also indicated that lice were unable to transmit *Salmonella* directly by bite. It is concluded that if lice become infected by feeding on a host with 1,000 bacteria per ml. blood or more (not an unusual level of bacteraemia in patients with enteric fever or the septicemic types of the disease), they have the same potential for transmitting *Salmonella* as, under similar circumstances, they would have for transmitting the agent of typhus.

O'Rourke (F. J.). *Anopheles* **and the problem of malaria in Canada.**— *Canad. Ent.* **91** no. 6 pp. 346–352, 36 refs. Ottawa, 1959.

There is now no indigenous reservoir of malaria infection in Canada, but the disease was formerly common there and the occurrence of cases caused by Korean strains of *Plasmodium vivax* in returning servicemen has given rise to speculation as to the possibility of its re-establishment. In view of this, the Anopheline fauna and the conditions required for transmission are reviewed. Six species of *Anopheles* are found in Canada. Of these, *A. quadrimaculatus* Say and *A. freeborni* Aitken are the most important vectors in the United States [*cf. R.A.E.*, B **35** 47], and *A. walkeri* Theo. has been found naturally infected there [**28** 122]. The other species (*A. punctipennis* (Say), *A. occidentalis* D. & K. and *A. earlei* Vargas) are readily infected in the laboratory and all three are stated not to have been found infected in nature [but *cf.* **24** 111]. The Canadian distribution [*cf.* **35** 47] and potentialities as vectors of the various species and their bionomics in the United States are briefly discussed. *A. quadrimaculatus* can readily be infected by exotic strains of malaria, including Korean *P. vivax*, in the United States. It occurs widely in southern Ontario and also along the southern fringe of Quebec, but the extent to which it feeds on man there is not known. *A. freeborni* has been found to show greater susceptibility than *A. quadrimaculatus* to infection with a United States strain of *P. vivax* [**41** 90], and to be susceptible to infection with strains from elsewhere. It has, however, only been found in southern British Columbia. *A. walkeri* has been found from Nova Scotia to Vancouver Island and is often rare. *A. occidentalis* and *A. earlei* were confused until recently [**42** 56–57]. The former does not occur east of the Rockies and is common in British Columbia and the Yukon. It does not invade houses and plays no part in transmission. Most Canadian records refer to *A. earlei*, the potentialities of which as a vector are unknown, though it bites man readily. It seems unlikely that any of the potential vectors can harbour *Plasmodium* over the winter, but females resting in houses during winter might pick up infection, and the relatively high temperatures maintained in houses would facilitate the development of sporozoites. It is thought that there might be a few primary cases of locally acquired malaria but that a lasting supply of infected insects would not be maintained, so that the occurrence of secondary cases is unlikely.

Alkan (B.). **Versuche zur Bekämpfung von Stechmückenlarven in Reisfeldern bei Ankara in den Jahren 1947–1950.** [Tests on the control of mosquito larvae in rice-fields near Ankara in 1947–50.]—*Z. angew. Ent.* **41** (1957) pt. 4 pp. 443–448. Hamburg [1958]. (With a summary in English.)

Tests on the control of mosquito larvae in irrigated rice-fields were carried out near Ankara in 1947–50 with a number of synthetic insecticides that had been found in the laboratory to give 100 per cent. kill of larvae in 24 hours. Of the Anophelines known in Turkey, *Anopheles hyrcanus* (Pall.) and *A. sergentii* (Theo.) are reported as developing in rice-fields, and observations by the author showed that *A. maculipennis* Mg., *A. sacharovi* Favr (*elutus* Edw.) and *A. superpictus* Grassi occurred near them, the first two species in swamps and the last in flowing water. The Culicines concerned comprised mostly *Culex pipiens* L. and *C. hortensis* Fic. The two genera were usually present in about equal numbers. Rice is sown in about mid-May, and the larvae were present from the end of June or beginning of July to the end of September or beginning of October. Plots, mostly of about 600 sq. yards, were treated as soon as larvae appeared and again whenever the population increased, and the effect of treatment was assessed 1 and 4–7 days after each application and again on subsequent occasions. The treatments included the application of a dust containing 5 per cent. DDT, granules of 1 per cent. dieldrin on bentonite and briquettes containing 0·15 per cent. γ BHC in gypsum at rates of 0·12, 0·0375 and 0·42 oz. per sq. yard, respectively. The periods that elapsed, in days, before additional applications were needed and (in brackets) the percentage reductions obtained in numbers of Anopheline larvae as compared with untreated plots were 51 (91) for DDT, 45 (75) for dieldrin, and 39 (69) for γ BHC when the briquettes were applied where the irrigation water entered the fields and 34 (73) when they were distributed over the plots. There were no phytotoxic effects. Other treatments, though they sometimes gave kills that were as good or better, did not give quite such long periods of effectiveness and presented, to a greater or a lesser extent, difficulties in preparation of the material or in their application. In practice, granules and briquettes were preferable to dusts or liquid preparations. The probable cause of the incomplete control in the plots was continual carriage of mosquito larvae by flowing water from untreated to treated areas, so that treatment of much larger areas would be needed for eradication.

Browne (S. G.). **Observations on *Simulium neavei* Roubaud, with special reference to a focus of onchocerciasis in the Belgian Congo.**—*Bull. ent. Res.* **51** pt. 1 pp. 9–15, 1 pl., 12 refs. London, 1960.

The identity and bionomics of the vector of *Onchocerca volvulus* were investigated in parts of a district in the tropical rain-forest area of the north-eastern Belgian Congo in which onchocercosis was generally endemic. The only species of *Simulium* found to attack man there was *S. neavei* Roub. About 10 per cent. of the females caught biting man were taken in shade near houses, about 2 per cent. near watercourses and the remainder in forest clearings, especially near coffee bushes, up to a mile from streams. Biting, which usually took place at less than 3 ft. from the ground, continued throughout the hours of daylight but was especially intense from 7.30 to 10 a.m. and from 4 to 5.30 p.m. Populations of the Simuliid seemed to increase in June and August. Of the females taken biting, 239 were dissected, and developmental forms of *O. volvulus* or a similar species were found in 12 and mature infective forms in one.

In the main focus of infection, which abuts on the River Congo, Simuliid larvae and pupae were found on crabs of the genus *Potamon* in the higher and less accessible reaches of rapid streams [*cf. R.A.E.*, B **40** 5; **45** 186] flowing into the Congo. The only difference discovered between streams that harboured crabs with larvae and pupae and those that did not was that the former had a current of 3·2–6·4 ft. per second. These infested streams were treated ten times at intervals of ten days with DDT from an emulsified solution at a concentration of 1:500,000 for 30 minutes. This treatment was lethal to the larvae and pupae of *Simulium* but not to the crabs. Good results obtained initially were, however, partly offset by the reappearance six months later of small numbers of larvae and pupae, apparently developing from eggs laid by females entering the treated area from outside. The problem in the second focus, some 20 miles south of the main river, seems insoluble because the numerous streams are situated in dense primary forest; only three larvae and two pupae were found on over 2,000 crabs examined from the accessible stretches of the numerous watercourses.

Saunders (D. S.). **The " white-clubbed " form of** *Syntomosphyrum* **(Hym., Eulophidae) parasitic on tsetse flies.**—*Bull. ent. Res.* **51** pt. 1 pp. 17–20, 8 refs. London, 1960.

Kerrich (G. J.). **The forms of** *Syntomosphyrum* **(Hym., Eulophidae) parasitic on tsetse flies.**—*T. c.* pp. 21–23, 3 refs.

Saunders (D. S.). **On the stages in the development of** *Syntomosphyrum albiclavus* **Kerrich (Hym., Eulophidae), a parasite of tsetse flies.**—*T. c.* pp. 25–31, 1 pl., 3 figs., 16 refs.

Syntomosphyrum glossinae Wtstn. was stated in the original description of material from *Glossina palpalis* (R.-D.) in Uganda [*R.A.E.*, B **3** 117] to have the funicle and club of the antenna dusky in the female, but the antennae of females that had emerged subsequently from a puparium of *G. morsitans* Westw. collected in Nyasaland [**4** 65] were white-clubbed. The males of the two forms appeared identical. An account is given in the first of these papers of cross-mating experiments made between white-clubbed and dark-clubbed forms in an attempt to clarify the taxonomic status of the former. A white-clubbed strain obtained from *G. morsitans* from Tanganyika and typical strains from *G. pallidipes* Aust. from Kenya and *G. palpalis* and *G. morsitans submorsitans* Newst. from Northern Nigeria were used. Crosses between the typical strains produced fertilised eggs and offspring of both sexes, but crosses in either direction between the typical and white-clubbed forms produced only males; these were presumed to have developed from unfertilised eggs, though mating appeared to take place in all cases. A physiological barrier to reproduction thus appears to exist between the two forms, and on these grounds the white-clubbed form is regarded as a distinct species.

The taxonomic problem is discussed in the second paper. Material of typical *S. glossinae* was examined from Nyasaland and from *G. palpalis* from Uganda, Nigeria and Liberia, *G. morsitans* from Tanganyika and *G. pallidipes* from Kenya,* and material of the white-clubbed form from *G. morsitans* from Nyasaland, Northern Rhodesia and Tanganyika. As the two forms were not interfertile and hosts and range overlap, although the typical form extends into moist, forested areas whereas the other is known

* We are informed by the author of the second paper that the record of *S. glossinae* from Nigeria, which was stated to be from *G. pallidipes*, was in fact from *G. palpalis*.—*Ed.*

only from dry savannah country, the latter is recognised as a distinct species although the morphological grounds for separation are weak. It is described as *S. albiclavus*, sp. n., from a female selected from the material reared from *G. morsitans* from Nyasaland in 1915.

In the third paper, the life-cycle and immature stages of *S. albiclavus* are described from material originating from pupae of *G. morsitans* from Tanganyika and bred on pupae of *Lucilia sericata* (Mg.). The egg is laid on the surface of the pupa and hatches in about 48 hours at 25°C. [77°F.]. The subsequent immature stages live in the space between the pupa and the puparium. Measurements of the widths of the cephalic skeletons of larvae of all ages showed them to fall into four well-separated groups, and it was confirmed that these represented four larval instars by the application of Dyar's law [A **17** 178]. The fourth instar lasts about five days, the others only about 24 hours and the pupal stage about ten days. The adults remain within the host puparium for about 24 hours after emergence, and then, by biting, make an emergence hole through which they escape; mating follows within a few moments.

Bursell (E.). **The measurement of size in tsetse flies** (*Glossina*).—*Bull. ent. Res.* **51** pt. 1 pp. 33–37, 2 figs., 8 refs. London, 1960.

The following is largely based on the author's summary. A convenient and accurate measure of size is necessary for studies on the physiology of tsetse flies (*Glossina*). Residual dry weight (*i.e.*, dry weight minus fat) is adequate as regards the larva, pupa and teneral fly but cannot be used for flies that have taken their first blood-meal because the blood-meal itself contributes so largely to the residual dry weight of the whole fly, which consequently undergoes extensive variations in the course of each hunger cycle. A linear measurement provides an index of size that remains constant throughout the life of the fly, but the use of the length of the middle part of the fourth longitudinal vein in the wing [*cf. R.A.E.*, B **34** 198] has certain disadvantages (notably poor correlation with the residual dry weight of unfed flies so that estimates of size based on small samples may be highly inaccurate), and a measure of surface was thought preferable. That finally adopted was a function of the dorsal thoracic surface, namely the product of the distance between the points of insertion of the largest of the lateral pronotal spines and the distance between the base of the scutellar spines and the mesonotal suture. A close correlation was demonstrated between it and residual dry weight for females of *G. morsitans* Westw. bred in the laboratory from puparia maintained at 28°C. [82·4°F.].

The relation between this measure and the weight of the newly emerged fly is affected by the temperature at which the pupal stage is passed. Above about 25°C. [77°F.], the surface area of flies of any given residual dry weight decreases quite sharply, so that puparia of a given weight produce smaller but relatively heavier flies at 30°C. [86°F.] than at 25°C. This holds good also for *G. pallidipes* Aust. and *G. swynnertoni* Aust., and is contrary to Jackson's statement, based on measurements of wing length, that the size of tsetse flies is determined at birth and is unaffected by conditions during pupal development [**41** 40]. The dependence of surface area on the temperature at which development has taken place unavoidably complicates the use of this measurement in work on transpiration. It also limits the application of the theory that stresses acting on the pregnant fly may be gauged from the size of flies two months later and suggests that where the mean temperature of pupal sites is likely to exceed 26°C. [78·8°F.], any inference should be based on puparial rather than adult size.

Bursell (E.). **The effect of humidity and temperature on the extent of abdominal pigmentation in** *Glossina pallidipes* **Austen.**—*Bull. ent. Res.* **51** pt. 1 pp. 39–46, 1 pl., 4 figs., 6 refs. London, 1960.

The following is largely based on the author's summary. E. Burtt discovered in 1953 that adults of *Glossina pallidipes* Aust. emerging from puparia kept in dry air failed to develop the dark abdominal banding normally characteristic of the species and that those emerging from puparia kept at high humidities showed intense blackening of the bands. He had previously noted in extensive collections of this species made at Shinyanga, Tanganyika, a seasonal variation in colour, with pale flies predominating at the end of the hot, dry season. Further investigations on variations occurring in the field and attempts to interpret them in terms of laboratory findings were made by the present author. The extent of pigmentation of the abdominal bands was studied in adults emerging in the laboratory from puparia kept at constant temperature and a range of relative humidities and derived from females collected in the field at Shinyanga. An index of pigmentation was obtained by regarding the bands as consisting in all of 15 zones, each carrying a score of 1. The index was closely dependent on the humidity experienced during pupal development, almost full pigmentation being produced in saturated air and a very considerable reduction of it in dry air. It is inversely related to size and little affected in nearly saturated air by temperatures below 28°C. [82·4°F.] during pupal development, although still higher temperatures reduce it quite sharply.

Among flies collected in the field throughout the year, most of those taken towards the end of the rains (March and April) fell into the darker-pigment categories. As the dry season advanced, the distribution tended to become bimodal with the darker mode relatively steady at an index of about 12 and the paler mode moving progressively down the scale, reaching an index of about 5 in October and then disappearing. Collections made in December and January (rainy season) were again unimodal, resembling those of March. It is suggested that these changes reflect the use of two types of larviposition site, the darker mode representing pupae from the evergreen thickets along the drainage lines and the lighter mode those from semi-deciduous thickets on the eluvial slopes, and that during the dry season the humidity of the air in the soil-spaces in the latter sites may reach levels inimical to survival. Burtt noted that puparia of *G. pallidipes* recovered in the early months of the dry season were found within about 0·4–1·2 in. of the surface, whereas at the height of the dry season most of the puparia were buried to a depth of 2–3 in. A study of the effect of air humidity and temperature on the burrowing of larvae indicated that the greater depth to which larvae burrow at the end of the hot season can be considered mainly as a response to high temperature, but that it is possible that the effect may be enhanced by the low humidities characteristic of this season.

The possible effect of air humidity on coloration was tested in four other species of *Glossina*, namely *G. swynnertoni* Aust., *G. morsitans* Westw., *G. palpalis fuscipes* Newst. and *G. longipennis* Corti. Only *G. swynnertoni* gave indications of some slight effect.

Bursell (E.) & Glasgow (J. P.). **Further observations on lake-side and riverine communities of** *Glossina palpalis fuscipes* **Newstead.**—*Bull. ent. Res.* **51** pt. 1 pp. 47–56, 3 figs., 11 refs. London, 1960.

The following is almost entirely based on the authors' summary. Earlier work in Nyanza Province, Kenya, had led to the conclusion that riverine

communities of *Glossina palpalis fuscipes* Newst. were permanently hungrier than lake-side communities [*R.A.E.*, B **42** 152]. This was based on analysis of catches (percentage of teneral flies in the whole catch, and percentage of females among non-teneral flies) and on a behaviour criterion (percentage of non-teneral males caught on the party), but subsequent observations in the two types of habitat, in which a different area was used to represent the lake side, showed the lake-side flies to be slightly smaller than the riverine flies, the size being measured by the length of the middle part of the fourth longitudinal vein in the wing [*cf.* **34** 198], and not to differ in fat content. A further investigation was accordingly made.

Puparia were collected on three dates between January and March 1958 and their surface area was measured. A measure of the thoracic surface [**48** 106] and fat content was also taken of all adults emerging. Non-teneral flies were collected, for comparison, about two weeks later than the puparia. In all samples, the riverine puparia were significantly larger than those from the lake side, and flies that emerged showed a comparable difference in size, but not in fat content corrected for size. Non-teneral riverine flies were slightly larger than lake-side ones, but the difference was less than half that shown by the puparia and the teneral flies obtained from them. Evidence is adduced that this discrepancy is due to elimination of the smaller flies in the lake-side community, because their fat reserve at emergence is insufficient to enable them to survive long enough to feed. Estimates of fat content of non-teneral flies support the conclusion that the lake-side community was under stress as compared with the riverine one, and analysis of available fly-round data from the lake side also suggests stress conditions.

The lake-side results are at variance with those from the site used in the earlier work. Available meteorological data show that the average temperature during February and March is 2°C. [3·6°F.] higher at the present site than at the former, and this difference may directly cause the stresses that appear to be operating in the present instance. The results suggest that the percentage of non-teneral males caught on the party has a real meaning in terms of nutritional status, and that it is also a very responsive indicator, but that the proportions of teneral flies and of non-teneral females may not be simply related to the nutritional state as had hitherto been supposed.

Goma (L. K. H.). **The swamp-breeding mosquitos of Uganda: records of larvae and their habitats.**—*Bull. ent. Res.* **51** pt. 1 pp. 77–94, 25 refs. London, 1960.

There are some 2,500 sq. miles of permanent swamps and probably as many of seasonal swamps in Uganda. These swamps are extremely varied in distribution, extent and nature and may be considerably altered by human interference, so that they provide a variety of breeding conditions for mosquitos. Out of 246 species, subspecies and varieties of mosquitos known from Uganda, 92 have been recorded either in the literature or in the author's personal observations in 1955–58 or both as breeding in the swamps, and a list of these swamp-breeders is given in this paper with notes on the prevalence and habitats of the larvae and references to the relevant literature. Only 58 forms were found breeding in swamps by the author, but they included six new records. Larvae representing some 14 unrecognised and probably undescribed species were also found in addition to the 92 definite records. There was a correlation between the distribution of certain species of mosquitos and certain types of swamp distinguished by their vegetation or position, as well as a definite zonal distribution of

some species within a swamp. In general, the interior of the large swamps was unfavourable to the breeding of Anophelines but favourable to Culicines, probably because of the high degree of organic pollution from decaying vegetation there, and not quite a quarter of the species that breed in swamps were Anophelines. Only 26 of the Uganda species appeared to breed exclusively in swamps and these included only one Anopheline, *Anopheles symesi* Edw., which is rare and of no medical importance. *A. coustani* Lav. was found under a wide range of swamp conditions, but *A. funestus* Giles and *A. gambiae* Giles did not normally breed intensively in the swamps though both occurred at the periphery, the latter less extensively. *Aëdes aegypti* (L.) does not occur at all in them. Breeding of mosquitos is profoundly affected when swamps are altered by human interference [*cf. R.A.E.*, B **46** 177]. In certain cases, this has resulted in increased production of Anophelines [**23** 93; **37** 163] with consequent aggravation of the malaria situation. Nevertheless, it appears that, in their natural state at least, the Uganda swamps are less important than has been supposed in relation to human disease, though many species of *Mansonia*, some of which are involved in the spread of filariasis [caused by *Wuchereria bancrofti*], are common swamp breeders.

Lewis (D. J.). **Observations on the *Simulium neavei* complex at Amani in Tanganyika.**—*Bull. ent. Res.* **51** pt. 1 pp. 95–113, 40 figs., 56 refs. London, 1960.

The following is partly based on the author's summary. Two members of the complex of *Simulium neavei* Roub. have been found at Amani, which is situated in the forest at an altitude of 3,000 ft. on the Usambara Mountains in Tanganyika. They have been described by the author as the Amani banded and unbanded forms, scientific names being withheld until the taxonomy of the whole complex is better understood. In October and November 1958, the author studied some aspects of their biology and anatomy, and some of his findings are discussed in this paper; descriptions are also given of some of the methods of study and of a simple water-flow meter. The larvae and pupae of both forms live externally on crabs. On the common local crab, *Potamon lirrangensis*, the number of pupae found amounted to roughly one pupa to seven crabs. Pupae of the unbanded form constituted a large proportion and predominated in the lower and more open parts of the drainage system examined. Neither form was abundant, but both were found at a much lower altitude (500 ft.) than any hitherto reported for the complex, probably because the temperatures at Amani are exceptionally low for the altitude and latitude, and the streams retain their mountain character at a lower altitude than elsewhere in East Africa. No unbanded adults were caught and virtually nothing is known of their habits. The variability of wing size of the banded form is described, and an account is given of observations on the internal anatomy of the adult with special reference to the ovaries, in which the follicular relics are usually very large; as these shrink rapidly in captive flies, this indicates that the female probably takes a blood-meal soon after oviposition. As has been demonstrated in *S. damnosum* Theo., there is an easily recognisable class of old flies with clear Malpighian tubes. Females of the banded form bit man readily, but only about five were taken per hour in good catching places and far fewer elsewhere. Nulliparous and parous females have rather different biting cycles.

Human onchocercosis has been reported from Amani but is not known to do any harm there. During the present work, single skin smears from 30 people were examined, and microfilariae, probably of *Onchocerca volvulus*,

were found in 14. It has been suggested that *S. neavei* is a more efficient vector of *O. volvulus* than is *S. damnosum*, and this may explain the existence of onchocercosis at Amani in the presence of rather small numbers of biting Simuliids. Out of 359 banded females dissected, 41·2 per cent. were parous and 12·8 per cent. of these contained nematodes, at least some of which were not *O. volvulus*. The taxonomic status of the Amani forms and the Simuliid-crab association are discussed. The unbanded and banded forms, which are regarded as species because, although living in the same area, they differ in larval, pupal and adult structure and in adult feeding habits, appear to be related to *S. neavei* and *S. woodi* De Meillon of Kenya, respectively. However, they differ from them biologically; the unbanded form has not been found biting man, as does *S. neavei*; the banded form, unlike the *S. woodi* of Kenya, pupates on the external surface of the crab and bites man readily [*cf. R.A.E.*, B **45** 186; **48** 37]. The crab association is regarded as commensalism, which has been defined as an ecological union in which both parties do not benefit but neither is harmed, and it is suggested that the crabs benefit the Simuliids by carrying them a short distance to a suitable current, thus enabling them to live in fast rivers and so extend their range from the smaller streams to which they seem, from the delicate gills of the pupae, to be better adapted.

Hocking (B.). **An insect-proof doorway.**—*Bull. ent. Res.* **51** pt. 1 pp. 135–144, 3 figs., 4 refs. London, 1960.

The following is almost entirely the author's summary. The effects of various factors on the passage of flying and crawling insects through a doorway were investigated in the laboratory with insects of four species, including *Musca domestica* L. From the results, it is considered practicable to exclude flying insects from a building or to prevent their successful escape from cages or rearing rooms by means of a downward air current if the speed of this in feet per minute multiplied by the ratio of the length through the doorway to its height is not less than 550. At all natural population densities, a combination of reflex and illuminated edges, smooth shiny walls without a pattern visible to insects, and a floor grid and underlying screening treated with a long-lasting residual insecticide would reduce to an insignificant level the number of insects that crawl through and survive. Artificially higher densities, as in rearing rooms, may require the doorway to be fitted with sliding doors in addition. These may be arranged to switch on the air current and lights as soon as they are opened.

Hanney (P. W.). **The mosquitos of Zaria Province, Northern Nigeria.**—*Bull. ent. Res.* **51** pt. 1 pp. 145–171, 8 figs., 12 refs. London, 1960.

The results are given of a survey of *Anopheles* in Zaria Province, Northern Nigeria, made between June 1957 and December 1958, within a radius of 50 miles from Kaduna, the regional capital, mainly to clarify the bionomics of known or possible vectors of malaria there. Attention was devoted chiefly to the four principal domestic species, *A. gambiae* Giles, *A. funestus* Giles, *A. nili* (Theo.) and *A. wellcomei* Theo., which were studied by means of regular floor-sheet collections carried out in the early morning after application of a pyrethrum spray, entrance- and exit-trap catches in native huts, and all-night catches of females biting inside and outside the huts. Data obtained at the same time on other species of *Anopheles* and on Culicines were also recorded. Short catches, from 7 p.m. to 10 p.m., were made about four times a month at one of two regular catching stations in

the bush, to ascertain the seasonal fluctuations in numbers of exophilous species; short night catches were also made in various localities to determine the distribution of species. The country is described. The wet season lasts from April to October. The studies showed that in this region, where malaria is holoendemic, all the four species feed indoors to some extent, although both *A. gambiae* and *A. nili* prefer to feed outside if a host is available. The only species found infected with malaria parasites were *A. gambiae* and *A. funestus*, which had sporozoite rates of 4 and 3 per cent., respectively, in the dry season and 6·7 and 7·7 per cent. in the wet season. They were almost the only Anophelines shown by floor-sheet collection to rest in huts by day. Collections on floor-sheets and catches at human bait showed that *A. gambiae*, *A. funestus* and *A. nili* were predominantly wet-season species, although in the more northerly of the two village areas studied, *A. funestus*, which was generally dominant there, occurred in fairly high numbers throughout the dry season also. *A. wellcomei* was predominantly a dry-season species. It was never taken in floor-sheet collections but was caught biting in nine of the eleven months in which collections were made.

The entrance, exit and biting times of *A. gambiae*, *A. funestus* and *A. nili* were ascertained by means of collections in traps and at human bait. The largest numbers of *A. gambiae* and *A. funestus* entered huts between 9 and 11 p.m. and left between 3 and 5 a.m., the period of maximum biting activity for *A. gambiae* being between midnight and 5 a.m., and for *A. funestus* between 11 p.m. and dawn. *A. nili* differed considerably from the other two species in that it had two peaks of maximum entry, one between 9 and 11 p.m. and the other between 1 and 3 a.m. The period of maximum exodus was between 1 and 5 a.m., and the peak of biting activity between 10 p.m. and 1 a.m. It was found that 64 per cent. of females of *A. gambiae*, 63 per cent. of those of *A. funestus* and 30 per cent. of those of *A. nili* leaving the huts between 1 and 5 a.m. were unfed. Maximum biting activity in *A. wellcomei* occurred between dusk and 9 p.m.

Apart from the four domestic species that have been discussed, the only common anthropophilous Anophelines around Kaduna were *A. coustani* Lav. and *A. theileri* Edw., which occurred in moderate numbers throughout the year, *A. flavicosta* Edw., which was most frequent in the middle of the dry season, and *A. rufipes* (Gough), which was absent during the first half of the rains. *A. coustani* bit at all hours of the night and *A. theileri* mainly between 8 p.m. and 2 a.m. The peak of biting was before 9 p.m. in both species. The commonest species of Culicines taken at human bait during outside night collections were *Mansonia africana* (Theo.), *M. uniformis* (Theo.), *M. cristata* (Theo.), *Aëdes lineatopennis* (Ludl.) and *Culex poicilipes* (Theo.). Of these, *M. uniformis* was by far the most regular and persistent biter throughout the year. *M. africana*, on the other hand, was taken in numbers only during October.

In an appendix (pp. 163–171), a list is given of the 17 species of *Anopheles* (two of them represented by two varieties), two species of *Toxorhynchites* and 65 of Culicinae known to occur in Zaria Province, with brief notes on their habits. *A. implexus* (Theo.) is recorded from Nigeria for the first time.

Thomas (P. L.). **Surface applicators for the control of lice and keds on sheep.**—*N. Z. J. agric. Res.* **1** no. 2 pp. 189–198, 11 refs. Wellington, N. Z., 1958.

An account is given of trials made in New Zealand to determine whether satisfactory control of lice (*Damalinia ovis* (Schr.)) and keds (*Melophagus ovinus* (L.)) on sheep could be obtained by the application to the surface

of the fleece, as a dust, a high-pressure mist or a low-pressure spray, of an insecticide, such as dieldrin, aldrin or diazinon, that can diffuse through the wool along the fibres [*R.A.E.*, B **44** 89; **46** 143]. In preliminary experiments, dieldrin was applied as a dust from a dusting race with eight outlets, three arranged vertically on each side and two on the floor, as an emulsified solution at 18 lb. per sq. in. from 20 nozzles arranged on five booms in a 9-foot race, and as a colloidal suspension at 120 lb. per sq. in. from 18 side jets and one overhead jet in a pipe-work frame that can be erected at the exit of an ordinary race. The dieldrin percentages in the dust, spray and mist were 3, 0·0625 and 0·2, respectively. In these and field dusting tests with 3 per cent. dieldrin dust applied from normal farm equipment, control was generally complete, except where there was human error or mechanical defect or the wool was very long. It is concluded that surface application of dieldrin at the strengths tested, either by dry or wet methods, can give satisfactory results, provided that at least 20 mg. active ingredient per kg. is deposited over the whole fleece, in the case of an 80 lb. animal. In small-scale dust tests, the performance of aldrin and diazinon was similar. It is possible that a 1·5 per cent. dieldrin dust, which was found effective in the United States against *M. ovinus* [**46** 83] would be adequate to give complete control, if applied at the same rate, if coverage is complete, and if the toxicant can be made to stay on.

Thomas (P. L.). **The control of lice** (*Damalinia ovis*) **and keds** (*Melophagus ovinus*). **A comparison of the efficiency of common insecticides.**—*N. Z. J. agric. Res.* **1** no. 2 pp. 217–223. Wellington, N. Z., 1958.

An account is given of trials, made in New Zealand during 1956 and 1957, comparing the efficiency of dips containing arsenic, BHC, aldrin and dieldrin in the control of lice (*Damalinia ovis* (Schr.)) on sheep and, in the latter year, of keds (*Melophagus ovinus* (L.)) also. Except in the case of arsenic, the dips were prepared from emulsion concentrates. At the minimum concentrations used (0·1 per cent. As_2O_3 and 0·00125 per cent. γ BHC, aldrin or dieldrin), they gave complete kill of the lice in every case and also at least three months' protection against reinfestation. All except arsenic were effective against keds. The lengthening of the protection period effected by a five-fold increase in the concentration of γ BHC was small. Jetting with 0·0025 per cent. diazinon and dusting with 3 per cent. dieldrin were also completely effective against both species.

Browne (L. B.). **The choice of communal oviposition sites by the Australian sheep blowfly** *Lucilia cuprina*.—*Aust. J. Zool.* **6** no. 3 pp. 241–247, 6 refs. Melbourne, 1958.

An account is given of a laboratory study of the factors that stimulate several females of *Lucilia cuprina* (Wied.) to lay their eggs in the same place, while ignoring other apparently suitable sites. The flies were kept at 80°F. and usually at 30 per cent. relative humidity in cages measuring 18 × 16 × 16 in. exposed to fluorescent lights, and were given fresh liver on the second and third days after emergence. They were generally used when ten days old. Pieces of freshly cut Merino fleece were placed in 150-ml. beakers to serve as oviposition sites, the stimulus to oviposition being provided by a cotton-wool plug, soaked in a solution of 0·04 per cent. indole and 2 per cent. ammonium carbonate, standing vertically in the fleece [*cf. R.A.E.*, B **36** 118]. Females were found to prefer to oviposit in cavities made in the fleece [*cf.* **47** 97], especially those near the moist

plugs. The cavities, which were $\frac{1}{2}$ in. in diameter and $\frac{3}{4}$ in. deep, were shown to be attractive primarily as places of relatively high humidity and low illuminance. When a choice was offered between fleece with a cavity adjacent to the plug and fleece with a cavity distant from the plug but with a pad of cotton-wool, moistened with water, forming one side of it, approximately as many eggs were laid in the one as in the other. Cavities were highly attractive as oviposition sites only when the air in them had a higher moisture content than the surrounding air. The presence of female flies in cavities stimulated other females to lay near them, though groups of female flies on the fleece surface did not, and neither eggs nor other deposits that may possibly be left by ovipositing flies had any influence on egg-laying. It is concluded that the preference of females for laying at places in which other females are already ovipositing is secondary in importance to the preference for laying in cavities.

CHRISTOPHERS (Sir S. R.). *Aëdes aegypti* (**L.**) **the yellow fever mosquito; its life history, bionomics and structure.**—$10\frac{3}{4} \times 7\frac{1}{2}$ in., xii + 739 pp., 86 figs., many refs. London, Cambridge Univ. Pr., 1960. Price £3 15*s*.

In this exhaustive account of the bionomics and structure of *Aëdes aegypti* (L.) in all its stages, the author brings together the results of his own observations and the information to be found in the vast and widely scattered literature. The importance of the work lies not only in the significance of *A. aegypti* as a disease vector but also in the extensive use made of it in the laboratory for basic investigation on mosquitos generally and the testing of insecticides and repellents. The first five chapters occupy together 130 pages and are of a comparatively general character. The subjects dealt with in them are, respectively, the history of the study of mosquitos in general and *A. aegypti* in particular, the systematics and variants of the species, including its distribution, its bionomics (including parasites and other natural enemies), its relation to the transmission of yellow fever, dengue and other diseases of man and animals and methods of controlling it (which are treated very briefly) and techniques of culture and study.

In the detailed stage-by-stage study that follows, a chapter is devoted to the egg (its external characters, structure and physical characters, the changes that follow oviposition, its viability under different conditions and its physiology) and another to hatching, largely as observed by the author; a third constitutes one of the first published descriptions of mosquito embryology. The general morphology of the larva, the various instars, physical characters of the larva and its relation to environment, growth and internal structure are dealt with in six chapters, and the external characters, chaetotaxy, tracheal, muscular and other systems of the pupa and its physical characters and cuticle are described and its behaviour, viability and emergence are discussed. Over 300 pages are given to the adult. A review of physical data is followed by detailed surveys of external characters and internal structure, the nervous system and retrocerebral complex, the special sense organs and the excretory and reproductive systems, and accounts of food and feeding (with a description of the act of taking a blood-meal), mating and oviposition, flight, reactions to light, smell, sound, heat and moisture and stimuli connected with feeding and oviposition, viability under different environmental conditions and physiology (including genetics, chromosomal structure and hormones). Much new information is incorporated, including the first published description of the mosquito brain. References are given at the end of each chapter. The index occupies some 18 pages.

Arthur (D. R.). **Ticks. A monograph of the Ixodoidea. Part V. On the genera** *Dermacentor*, *Anocentor*, *Cosmiomma*, *Boophilus* **and** *Margaropus*.—10 × 7 in., xviii + 251 pp., 4 pls., 510 figs., 2 graphs, 10 pp. refs. London, Cambridge Univ. Pr., 1960. Price £3.

This is the fifth part of a work planned to provide a comprehensive survey of the classification, structure and biology of ticks. The first part, on Argasids, by G. H. F. Nuttall, C. Warburton, W. F. Cooper & L. E. Robinson, appeared in 1908, and the second, on the classification of the Ixodids and on the genus *Ixodes*, by Nuttall & Warburton, in 1911. The third and fourth parts [*R.A.E.*, B **4** 34; **14** 49] dealt with the genera *Haemaphysalis* and *Amblyomma*, respectively. In this part, the morphology and anatomy of members of the genus *Dermacentor* are described at some length in a general introductory section as a background to the review of the various species. These are grouped geographically into American, Eurasiatic and African species. Keys are given to the adults, of both sexes where known, of each group and to the nymphs of some of the American species. For each species, there is a list of references to the literature on its taxonomy, followed by descriptions and figures and generally a summary of the bionomics, hosts, distribution and significance as a disease vector, if any. A list is also given of condemned and doubtful species.

For each of the other four genera, a list of references to taxonomic work and the generic characters are given, together with descriptions and figures of the species and notes on bionomics, distribution and hosts. There are also keys to the adults of both sexes of *Boophilus* and *Margaropus* and indications of the diseases of domestic animals transmitted by species of *Boophilus*. *Anocentor* and *Cosmiomma* each contain one species only, *A.* (*Otocentor*) *nitens* (Neum.) [*cf.* **30** 127] and *C. hippopotamensis* (Denny).

Kartman (L.). **The concept of vector efficiency in experimental studies of plague.**—*Exp. Parasit.* **6** no. 6 pp. 599–609, 25 refs. New York, N. Y., 1957.

To compare the potentialities of different species of fleas for the transmission of plague bacilli, Wheeler & Douglas [*R.A.E.*, B **30** 33] and Kartman, Prince & Quan [**46** 163] used a figure for vector efficiency which was the product of infection potential (ratio of the number of fleas becoming infected to the number fed on an infected host), vector or blocking potential (ratio of transmitting fleas or fleas with a permanently blocked proventriculus to infected fleas) and transmission potential (ratio of transmissions, *i.e.*, infected mice, to transmitting fleas fed daily until death on individual mice). It is shown that vector efficiency can be derived much more simply by taking the ratio of plague transmissions to the number of fleas used, so that an experiment to determine vector efficiency need not include the lengthy observations necessary to obtain data on infection and blocking rates. Nevertheless, from the ecological point of view, every important factor contributing to vector capacity should be studied in order to determine on which factor the vector efficiency is primarily based under the conditions studied. Kartman, Prince & Quan multiplied vector efficiency by the blocking-survival potential [**46** 163], to derive a vector index. However, vector efficiency and vector index represent only a few of the factors actually involved in a total concept of vector capacity. An efficiency index including pertinent data from field studies is needed. Such data include the natural infection rate of the fleas, their prevalence and length of life in the field, their transfer potential between wild rodents and domestic rats, their ability to retain plague infection and to become infective under given

conditions of temperature and humidity, and their predilection for known rodent reservoirs of plague. Quantitative data on the habits, movements, habitats and prevalence of the principal rodents concerned are probably also important. As, hypothetically, the plague vector potential of a flea population in any given set of ecological conditions is ultimately a function of the susceptibility of the individual flea to the plague bacillus, the biochemical physiology of the flea-plague relationship must be investigated for the basic understanding of the vector potential. As a stage in the development of a more significant index, an index of the plague vector potential of individuals of a given species of flea under specific conditions is proposed, to be obtained by multiplying by 100 the product of the experimental vector index, obtained under strictly controlled conditions, the field infection index (the rate of plague infection in fleas or in flea pools taken from rodents and/or rodent burrows and nests, under specified conditions) and the field prevalence index (the mean number of fleas of a given species per rodent and/or rodent nest or burrow at a specified time of year).

As examples, the vector potential index and the figures on which it is based are given for *Malaraeus telchinum* (Roths.) and *Hystrichopsylla linsdalei* Holland, the species previously referred to as *Hystrichopsylla* sp., both of which were associated with a plague epizootic in the San Francisco Bay region [**47** 58, 159–160]. For *H. linsdalei*, the experimental blocking index, field infection index, field prevalence index and vector potential were 0·02, 0·11, 0·08 and 0·02, respectively. For *M. telchinum*, the corresponding figures were 0, 0·04, 0·43 and 0. These figures are obtained by methods that measure the vector potential of individual fleas and do not attempt to measure the phenomenon of mass transmission, which constitutes a separate, but related, problem. *M. telchinum* seldom shows proventricular blockage in laboratory studies and is at present regarded as a flea that transmits plague primarily by mass transmission (presumably by mechanical contamination). This, together with its known prevalence on certain wild rodents and its natural infection rate, makes it an important species in the study of epizootic plague. The vector potential index shows that it is inefficient on an individual basis.

Jackson (E. B.), Danauskas (J. X.), Coale (M. C.) & Smadel (J. E.). **Recovery of *Rickettsia akari* from the Korean vole *Microtus fortis pelliceus*.**—*Amer. J. Hyg.* **66** no. 3 pp. 301–308, 22 refs. Baltimore, Md., 1957.

Rickettsialpox, which is caused by *Rickettsia akari* transmitted by *Allodermanyssus sanguineus* (Hirst), an ectoparasite of the house mouse, was first recognised and studied in New York and subsequently found to occur in other parts of the eastern United States [*R.A.E.*, B **44** 17]. A disease closely resembling and apparently identical with it, occurring in the Soviet Union [**44** 152], was described in 1949–50 by Russian investigators; cases clinically resembling rickettsialpox have also been reported from the Oubangui-Chari area of French Equatorial Africa. No reservoirs other than commensal mice and rats [**44** 152] have hitherto been known. In this paper, an account is given of the identification as *R. akari* of an agent recovered from a reed vole (*Microtus fortis pelliceus*) trapped in Korea in October 1952. The agent was not recovered from any others of some 200 Korean rodents examined during 1952 and 1953. The demonstration of the natural occurrence of *R. akari* in a field rodent, together with the fact that rickettsialpox has not been recognised in the human population of the area

and the demonstration of transovarian transmission of the agent in *A. sanguineus* by Russian workers [**44** 153], suggests the existence of a natural cycle independent of man or commensal rodents.

Jackson (E. B.) & others. **Occurrence of *Rickettsia tsutsugamushi* in Korean rodents and chiggers.**—*Amer. J. Hyg.* **66** no. 3 pp. 309–320, 1 fig., 30 refs. Baltimore, Md., 1957.

Tsutsugamushi disease was rare among United Nations troops in Korea, only eight cases being recognised in 1951–54, yet *Rickettsia orientalis* (*tsutsugamushi*) was recovered from three species of wild rodents trapped near the 38th parallel between April 1952 and April 1953 and from 11 of 77 individuals and all of five pools of *Apodemus agrarius*, the rodent most frequently collected in the combat area, as well as from one of the nine individuals of *Microtus fortis* and from each of the single pools of that species and of *Micromys minutus* tested. Strains of *R. orientalis* were also recovered from larvae of *Trombicula pallida* Nagayo et al., which were the laboratory-reared progeny in the F_1 generation of mites collected in 1954 in the areas that yielded infected wild rodents, but no evidence of this *Rickettsia* was obtained when several thousand unidentified larval Trombiculids were inoculated into mice, in contrast with experience in Malaya [*R.A.E.*, B **41** 5]. *T. pallida* was the commonest Trombiculid [*cf.* **43** 162]. Chilled larvae were transported to Washington, D.C., where they were reared in mass culture on a floor of hardened plaster of paris and activated charcoal covered with vermiculite [*cf.* **39** 146; **43** 181] in rectangular vessels with tightly fitting glass lids. The larvae were fed on mice, preferably recently weaned ones, and food was provided for the nymphal and adult mites by the eggs produced by colonies of *Sinella curviseta* Brook [*cf.* **43** 180] that were maintained in the containers, the floors of which were moistened at frequent intervals; the containers were kept on tables that were treated with an acaricide to prevent the escape of the Trombiculids. In 12 experiments, F_1 larvae were allowed to feed on suckling or weanling white mice and the mice were subsequently examined for the presence of rickettsiae; in six of the experiments, *R. orientalis* was found to have been transmitted by the larvae of *T. pallida* during feeding. It was shown that infection could be transmitted during the first 24 hours of attachment. It is assumed that *T. pallida* is concerned with the maintenance of infection [*cf.* **44** 187] among Korean wild rodents but infrequently transmits it to man. *T. akamushi* (Brumpt) and *T. deliensis* Walch, the classical vectors of tsutsugamushi disease, were not found in Korea.

Hoogstraal (H.) & Kaiser (M. N.). **The Ticks (Ixodoidea) of Egypt. A brief review and keys.**—*J. Egypt. publ. Hlth Ass.* **33** no. 3 pp. 51–85, 40 refs. Cairo, 1958.

A list is given of 30 species of ticks that occur in Egypt, with keys to the adults, data on hosts and often notes on local distribution and prevalence and references to literature containing information on bionomics, morphology and significance in relation to disease. One other species included, *Argas reflexus* (F.), is stated in a footnote to have been found not to occur in Egypt and probably not in Africa [*cf. R.A.E.*, B **42** 182], the common species of *Argas* on pigeons in Egypt being *A. hermanni* Aud. A further list is given of species that have been introduced into Egypt but have not become established and one indigenous tick that no longer occurs there.

Duca (M.), Duca (E.), Tomescu (E.) & Oană (C.). **Cercetări asupra rolului muştei de casă în transmiterea infecţiei cu virus Coxsackie.** [Investigations on the part played by *Musca domestica* in the transmission of infection with Coxsackie virus.]—*Stud. Cercet. Inframicrobiol.* **9** pt. 1 pp. 31–41, 20 refs. [Bucharest] 1958. (With summaries in French & Russian.)

The following is almost entirely based on the French summary. Coxsackie virus of type A10 was isolated in Moldavia, eastern Rumania, from house-flies (*Musca domestica* L.) collected in September and October in three out of five dwellings investigated in localities that constituted foci of infection with this virus, at a time when the virus was no longer being eliminated in the faeces of persons who had recovered from the disease or in those of contacts. A patient suffering from aseptic meningitis and two apparently healthy contacts showed neutralising antibodies at a very high titre for the strain of virus isolated from flies from the same dwelling. House-flies that were fed experimentally on infected food eliminated Coxsackie virus in the excreta and in regurgitated matter. The virus was excreted by the flies for 16 days after an infective meal, and survived for 37 days at room temperature in dry excreta on paper [*cf. R.A.E.*, B **43** 58]. It was not transmitted through the egg, but was passed from one generation to another at hatching. Virus ingested by larvae with food did not remain after pupation. Infection died out in adults in 16–20 days. Measures recommended to restrict the spread of infection are fly control, neutralisation of sources of virus and protection of food.

Wilkinson (P. R.) & Wilson (J. T.). **Survival of cattle ticks in central Queensland pastures.**—*Aust. J. agric. Res.* **10** no. 1 pp. 129–143, 8 figs., 16 refs. Melbourne, 1959.

The following is virtually the authors' summary. Observations on the gradual distension and shrinkage of larvae of *Boophilus microplus* (Can.) confirmed that they can take up water from, or lose water to, the atmosphere under suitable conditions [*cf. R.A.E.*, B **45** 160]. Further evidence was obtained that partly desiccated larvae can drink when in contact with free water. Consideration of the relative humidities recorded over sward adjoining a creek, during a drought, suggested that larvae would be able to absorb moisture during the nine-hour period before dawn. Dew was also available to the larvae in drought time, and on most mornings when observations were made. In the laboratory, larvae in cultures supplied with water droplets lived longer than those in similar cultures not supplied with water. Clusters of larvae on artificial supports out of doors lived longer if protected by fabric shades.

At intervals over two years, female ticks were placed on grassland near Rockhampton and at Yeppoon, in coastal central Queensland, under simulated natural conditions. The times of hatching and periods of survival of the larvae were observed. In contrast with ticks in southern Queensland, which show a marked decrease in fertility in the winter, ticks put out throughout the winter at Rockhampton laid large numbers of fertile eggs. Very few larval progeny of ticks put out in summer survived three months after the date on which the female parent was first put out. Progeny of ticks put out in the winter persisted up to 5½ months after the date on which the parent was first exposed. A graph of the "pre-hatch" (pre-oviposition plus developmental) periods against screen temperatures followed the trend expected from laboratory data, but the difference between actual and computed hatching dates was large in some cases. Actual

hatching date was usually later than computed hatching date, both for ticks in the soil and for ticks in humidified containers in a meteorological screen. The comparatively short survival periods of larvae in the central Queensland summer indicated the practicability of controlling the cattle tick by temporarily destocking pastures [**47** 176].

METCALF (R. L.). Ed. **Advances in pest control research. Volume III.**—9¼ × 6 in., vii + 448 pp., 33 figs., many refs. New York, N.Y. & London, Interscience Publishers, Inc., 1960. Price £5 9*s*.

The articles in this third volume of a series [*cf. R.A.E.*, B **48** 86, etc.] include **Male sterilization for the control of insects,** by R. C. BUSHLAND (pp. 1–25, 28 refs.) who reviews principally the use of radiation for sterilising the males of *Callitroga hominivorax* (Coq.) and investigations on the value of releasing sterilised males for control of this screw-worm in nature [*cf.* **44** 103–104, etc.]; **Joint action in insecticides,** by P. S. HEWLETT (pp. 27–74, 3 graphs, 278 refs.), who reviews the concepts of antagonism and synergism, the synergists that have been developed for pyrethrins and allethrin and for DDT and related compounds, and their chemical structure, synergistic activity and mode of action, and problems in the measurement of responses for joint action, with a note on the control of resistant strains of insects; **The labeled pool technique with particular reference to pesticide research,** by F. P. W. WINTERINGHAM (pp. 75–127, 8 figs., 85 refs.), who explains the use of radioactive tracers combined with paper chromatography for studying the effects of insecticides or other toxicants on suitably labelled biological systems, such as insects or plants, in comparison with material not treated with toxicants, the term labelled pool referring to a range of biochemically related metabolites labelled with a suitable radioisotope, and reviews the procedures and techniques involved and the treatment and evaluation of the data obtained; **Recent developments in chemical attractants for insects,** by N. GREEN, M. BEROZA & S. A. HALL (pp. 129–179, 259 refs.), who discuss the entomological uses of attractants, the types available and their properties, methods of testing attractants, the attractants developed for use against numerous individual insect species, and the relation of attractancy to molecular structure; and **DDT-dehydrochlorinase,** by H. LIPKE & C. W. KEARNS (pp. 253–287, 8 graphs, 58 refs.), who review the discovery, inheritance, inhibition by synergists, purification and properties of the enzyme (DDT-dehydrochlorinase) that converts DDT into DDE in DDT-resistant house-flies [*Musca domestica* L.] [*cf.* **46** 163; **47** 50] and possibly also in other insects, though it has not been definitely demonstrated in these. A cumulative index to the articles in the three volumes so far published is appended.

ROBBINS (W. E.), HOPKINS (T. L.), DARROW (D. I.) & EDDY (G. W.). **Studies with P^{32}-Bayer 21/199 sprayed on cattle.**—*J. econ. Ent.* **52** no. 2 pp. 214–217, 14 refs. Menasha, Wis., 1959.

The following is based largely on the authors' summary. The metabolism, excretion and distribution in the tissues of ^{32}P-labelled Bayer 21/199 [O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl phosphorothioate] were studied in two bulls that had been sprayed with the radioactive toxicant, applied as a suspension to one and as an emulsion to the other. The animals were prevented from ingesting insecticide from their bodies or bedding. Only low levels of radioactive compounds were found in the blood, and these did not

behave like the parent compound or its corresponding phosphate. The compound appeared to have been sparingly absorbed, about 2·4 and 6·3 per cent. of the applied dose being accounted for in the urine of the suspension- and emulsion-treated bulls, respectively, in the two weeks following treatment. At the end of the two weeks, only very low levels of organo-soluble compounds behaving like 21/199 were present in the tissues, but a considerable residue of unchanged 21/199 was present on the hide.

Rai (L.) & Roan (C. C.). **Interactions of topically applied piperonyl butoxide and malathion in producing lethal action in house flies.**— *J. econ. Ent.* **52** no. 2 pp. 218–220, 1 fig., 9 refs. Menasha, Wis., 1959.

The nature of the antagonistic effect of piperonyl butoxide on the toxic action of malathion on *Musca domestica* L. [*cf. R.A.E.*, B **45** 112] was investigated in experiments in which acetone solutions of the two substances were applied topically in varying combinations to various sites on the body of males reared at about 80°F. The flies used in the test, which was carried out at approximately the same temperature, were four days old and in all experiments, except one on duration of effect, were of a DDT-susceptible strain. The toxicity of malathion alone, applied at 0·27 μg. per fly, was greatest when application was to the thoracic sternum or proboscis and head and much less when it was to the notum or abdominal sternum, suggesting that the closer the application is to the brain and thoracic ganglion, the higher is the mortality. The same trend was shown when malathion at 0·375 μg. per fly (increased to compensate for possible antagonism) was applied in combination with ten times as much piperonyl butoxide, and antagonism was apparent. The antagonistic effects of piperonyl butoxide on malathion were evident even when the two were applied almost simultaneously to separate areas of the integument. When about 2·58 μg. piperonyl butoxide and 0·27 μg. malathion were applied to each fly, the percentage mortality caused by malathion on the mesosternum was reduced from 70 to 54 by the application of piperonyl butoxide to the abdominal sternum, and the percentage mortality caused by malathion on the abdominal sternum was reduced from 38 to 22 by piperonyl butoxide on the mesosternum. These data strongly suggest that piperonyl butoxide does not slow down the rate of penetration of malathion, and the similarity of the ratios of percentage mortality to that found in earlier work [*loc. cit.*], when the two were applied together, indicates that the level of antagonism is not dependent on the application of the two materials to the same areas. The final experiment was carried out with flies of a strain that was resistant to DDT and twice as resistant to malathion as the strain used in the other experiments; it showed that, when piperonyl butoxide (4·28 μg. per fly) was applied first to the mesosternum, followed at varying intervals by malathion (0·428 μg.) at the same site, the antagonistic effects decreased slowly as the interval between applications rose to 30 hours but when the order of treatment was reversed, the antagonistic effects decreased rapidly as the interval between the applications of malathion and piperonyl butoxide rose from 1 to 30 minutes. Treatment with piperonyl butoxide 1–2 hours before malathion was applied resulted in markedly greater antagonism than that observed for simultaneous applications, but no such increase was observed when the order of treatment was reversed. It therefore appears that the antagonistic action of piperonyl butoxide is relatively persistent, that the toxic action of malathion is rapidly initiated and that its susceptibility to the antagonistic effects of piperonyl butoxide decreases relatively rapidly.

Zingrone (L. D.), Bruce (W. N.) & Decker (G. C.). **A mating study of the female house fly.**—*J. econ. Ent.* **52** no. 2 p. 236, 2 refs. Menasha, Wis., 1959.

A study of the mating habits of *Musca domestica* L. was made possible by the isolation, from a field strain, of a pure strain with green eyes. Green eye colour was found to be a simple autosomal recessive. Three experiments were made in which females were first mated in isolated pairs with a male of one strain and were then given the opportunity to mate again with a male of the other after they had laid eggs that hatched, showing that fertilisation had been effected. Of 130 females used, 100 produced progeny that became adult, and the offspring of only two females showed that the parent females had mated for a second time. Both of the second matings occurred shortly after a normal-eyed male was put in with a green-eyed female that had mated first with a green-eyed male. The first fertilisation was effective for the entire egg-laying period, and females that mated twice gave rise to both types of progeny in the first batch of eggs produced after their second mating and on each day thereafter.

Lewis (L. F.) & Eddy (G. W.). **Control of mosquito larvae in log ponds in Oregon.**—*J. econ. Ent.* **52** no. 2 pp. 259–260, 3 refs. Menasha, Wis., 1959.

The effectiveness of DDT, heptachlor and malathion in emulsion sprays at 1, 3 and 6 lb. technical material per acre was compared in the Corvallis area of western Oregon in 1957 for the control of mosquito larvae in log ponds [*cf. R.A.E.*, B **46** 197; **47** 29]. Most of the treated ponds were near untreated ones, and many viable egg-masses appeared in them throughout. The period of protection (which was deemed to have ended when fourth-instar larvae were observed) ranged from 3 to 6 weeks with DDT, 5 to more than 10 weeks with heptachlor and 2·5 to 6 weeks with malathion; it increased with increasing dosage in each case. No relation was found between control and the turbidity, pH value or depth of the water. Observation of the species present during the year after the beginning of treatment (July 1957 to June 1958) showed that *Culex pipiens* L. predominated in June and July and *C. peus* Speiser (*stigmatosoma* Dyar) in August, September and October. Except in the cooler months, from October to the end of May, *C. tarsalis* Coq., *C. territans* Wlk. and *Culiseta incidens* (Thoms.) formed relatively small percentages of the total. Nevertheless, populations of *Culex tarsalis*, a potential disease vector, were considerable.

Bar-Zeev (formerly Wolfinsohn) (M.) & Smith (C. N.). **Action of repellents on mosquitoes feeding through treated membranes or on treated blood.**—*J. econ. Ent.* **52** no. 2 pp. 263–267, 1 fig., 25 refs. Menasha, Wis., 1959.

To eliminate the element of variability introduced into tests of mosquito repellents by the use of a living host, a method was devised for testing them in which *Aëdes aegypti* (L.) was fed on citrated blood through a membrane derived from ox caecum [*R.A.E.*, B **48** 13]. Three repellents were applied at various concentrations to the membrane or blood, and the concentration required to give 50 per cent. repellency was determined. The apparatus used is described. The factors affecting feeding were

investigated and it was shown that the percentage of mosquitos that fed rose with an increase in blood temperature from 28 to 36°C. [82·4–96·8°F.] and with an increase from ½ to 7 hours in time elapsing between anaesthesia by carbon dioxide or cold (5°C. [41°F.]) and feeding. In the tests, citrated blood, maintained at about 36°C. [96·8°F.] was offered to mosquitos that had been anaesthetised and put in small feeding cages 24 hours before and were kept at 28°C. [82·4°F.] and 70–80 per cent. relative humidity. Under such conditions, over 90 per cent. of the mosquitos fed, whether honey and water had been available during the interval or not. Whether applied on the membrane or in the blood, diethyl toluamide was the strongest repellent, followed in order by dimethyl phthalate and ethylhexanediol. On the membrane, the amounts per sq. inch needed to give 50 per cent. repellency were 1·7, 2 and 4·8 mg., respectively. Differences between compounds were significant near the level of 50 per cent. repellency but not always at higher or lower levels. An experiment in which contact of the tarsi with the membrane treated with dimethyl phthalate was prevented by the interposition of another membrane or a wire screen, so that the effect of the repellents on the tarsal chemoreceptors might be studied, indicated that repellency was due to the vapour only, at least at the concentrations of repellent used. When the repellents were emulsified in the blood, the concentration percentages causing 50 per cent. repellency were 0·04 for diethyl toluamide and 0·089 for dimethyl phthalate; the highest concentration of ethylhexanediol tested (0·1 per cent.) caused only 6·6 per cent. repellency. It was shown that the effectiveness of low concentrations of diethyl toluamide and dimethyl phthalate in the blood was not due to absorption in or on the membrane. As 0·1 per cent. diethyl toluamide gave 99 per cent. repellence, rabbits were injected intravenously with sufficient to produce a concentration of 0·4 per cent. in their blood; mosquitos to which the rabbits were exposed ¼–4 hours after injection were not repelled, and a further experiment indicated that the compound was rapidly destroyed or removed from the blood.

Bar-Zeev (formerly Wolfinsohn) (M.) & Schmidt (C. H.). **Action of a repellent as indicated by a radioactive tracer.**—*J. econ. Ent.* **52** no. 2 pp. 268–269, 4 refs. Menasha, Wis., 1959.

To determine whether the repellency of certain chemicals to mosquitos was due solely to vapour action or whether contact chemoreceptors were involved [*cf.* preceding abstract], two experiments were carried out in which females of *Aëdes aegypti* (L.) were given the opportunity of feeding through a membrane on citrated blood containing diethyl toluamide, and ^{32}P-labelled phosphoric acid was added as a tracer to the blood or applied to the surface of the membrane. Counts of radioactivity on the proboscis and tarsi of mosquitos that had been offered treated blood showed that when diethyl toluamide was present in the blood at a concentration (0·5 per cent.) that prevented the mosquitos from engorging, the latter barely touched the membrane and did not insert the proboscis into the blood. When the concentration was lowered to one (0·065 per cent.) that allowed about half the mosquitos to feed during a three-hour exposure, those that did not feed spent slightly more time in contact with the membrane, and about a third of them inserted the proboscis into the blood but did not imbibe. It is concluded that most of the repellency was due to vapour action, but contact chemoreceptors on the labella, which have been shown to exist in *A. aegypti*, may have been involved when the concentration of repellent was low.

Gatterdam (P. E.), Casida (J. E.) & Stoutamire (D. W.). **Relation of structure to stability, antiesterase activity and toxicity with substituted-vinyl phosphate insecticides.**—*J. econ. Ent.* **52** no. 2 pp. 270–276, 1 fig., 26 refs. Menasha, Wis., 1959.

The following is based on the authors' abstract. Phosdrin [dimethyl 2-methoxycarbonyl-1-methylvinyl phosphate], OS-1808 [diethyl 2-ethoxycarbonyl-1-methylvinyl phosphate], OS-1836 (diethyl 2-chlorovinyl phosphate) and many related substituted-vinyl phosphates were found to be mixtures of geometric isomers that could be separated by partition chromatography with silica-gel columns. The isomer first eluted (termed the α isomer) was the major component. It was more toxic to rats and adults of *Musca domestica* L., more potent in inhibiting blood cholinesterase, more rapidly attacked by permanganate and less stable in alkali and in plants than the second (β) isomer. The configuration of the isomers is unknown, and a third (γ), of low toxicity, was found in OS-1836.

Irradiation of either the α or β isomer of OS-1808 with ultraviolet light resulted in a mixture of α and β isomers (3:7); the presence of 10 parts β to 1 part α isomer had no effect on the toxicity of the latter to *M. domestica*. Dimethyl 2-methoxycarbonyl-2-chloro-1-methylvinyl phosphate was found as an impurity in technical Phosdrin; it proved only half as toxic as the pure compound to rats and aphids and still less so to *M. domestica*. Hydroxyproline and certain pyridine aldoxime methiodides were the most active of 55 amino acids and related chemicals tested as catalysts for the hydrolysis of α Phosdrin. Comparison of the α fractions from 23 substituted-vinyl phosphates showed no distinct correlation between alkaline stability, toxicity to rats and *M. domestica* and anticholinesterase activity. Many of the substituents about the vinyl grouping resulted in compounds of quite high insecticidal activity.

Wilson (H. G.), LaBrecque (G. C.), Gahan (J. B.) & Smith (C. N.). **Insecticide resistance in seven Orlando house fly colonies.**—*J. econ. Ent.* **52** no. 2 pp. 308–310, 3 refs. Menasha, Wis., 1959.

Seven insecticide-resistant strains of *Musca domestica* L. have been established in the laboratory at Orlando, Florida, and tests to determine their resistance to various insecticides in comparison with that of a colony of normal flies are described. Females 4 or 5 days old from all colonies were exposed to kerosene solutions of the test compounds applied as sprays in a wind tunnel [*cf. R.A.E.*, B **47** 85]. one colony was tested with acetone solutions in sugar, as it had originated in localities in which baits were used as the principal method of control, and two were exposed to deposits from acetone solutions on plywood.

The Orlando no. 1 colony, in which experimental development of resistance to DDT was first demonstrated [*cf.* **38** 94], was established in January 1946 and is maintained in cages coated with DDT; residue tests using plywood panels indicated the resistance of the 245th generation to DDT to be more than 500 times that of the normal colony, and no mortality was caused when females of the 270th generation were exposed to 64 per cent. contact sprays, whereas the LC50 for the normal flies was 0·2–0·8 per cent. Selection for intermediate resistance was maintained in the LDD colony, established in July 1951 from flies collected in local dairies and now in the 164th generation, by constant exposure to panels treated with γ BHC (lindane), dieldrin and DDT. Females of this colony, when sprayed, showed about 40-fold resistance to γ BHC in the 150th and 160th generations, complete resistance to dieldrin (concentrations of 48 per cent. giving

little or no mortality in the 140th and 150th generations) and 60- and 100-fold resistance to DDT in the 160th and 150th generations, respectively; in residue tests, using panels, the 98th and 143rd generations showed 40-fold resistance to deposits of DDT. The C colony, exposed in each generation to 0·02 per cent. trichlorphon (Dipterex) in the diet, showed about tenfold resistance to this toxicant when collected in December 1953 from barns that had been intensively treated with various organophosphorus baits, but it developed no additional resistance after selection for 98 generations, and was then discontinued. The Bayer 21/199 colony, established in February 1956 from the 101st generation of the LDD colony, had developed greater than 90-fold resistance to Bayer 21/199 [O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl phosphorothioate] after exposure to contact sprays for 50 generations, and the 57th and succeeding generations were maintained in a cage coated with a deposit of this insecticide. Resistance to malathion in the Grothe colony [**47** 85] rose to about 100-fold in 20 generations. The Tropical D colony showed 34-fold resistance to diazinon when collected in Florida in June 1957 and 62-fold resistance after selection for 20 generations, and the Tropical P colony, established from the same group of flies as were used to start the preceding, showed greater than 18-fold resistance to parathion when collected and no increase after 20 generations. Selection in the last three colonies was made by exposure to contact sprays.

Hilsenhoff (W. L.). **The evaluation of insecticides for the control of *Tendipes plumosus* (Linnaeus).**—*J. econ. Ent.* **52** no. 2 pp. 331–332, 8 refs. Menasha, Wis., 1959.

Serious outbreaks of *Chironomus* (*Tendipes*) *plumosus* (L.) have caused annoyance in the Lake Winnebago area of Wisconsin for several years, and methods of control that have been used against other midges in various parts of the world have proved to be ineffective, too costly or lethal to fish. As the hazard from toxic deposits is usually less with organic phosphate insecticides than with chlorinated hydrocarbons, 16 commercially available ones, incorporated in attapulgite granules, were tested in the laboratory for their relative toxicity to the larvae of *C. plumosus* and to the minnow, *Pimephales promelas*. Dichlorvos (DDVP), trichlorphon (Dipterex), EPN, Guthion, malathion and Phosdrin all showed considerable toxicity to the larvae at concentrations of 0·1 lb. technical insecticide or less per acre. The three of these insecticides that were least toxic to the minnows were dichlorvos, trichlorphon and malathion. These, in replicated tests, showed no toxicity to the minnows at 50, 100 and 20 lb. technical material per acre, respectively, and killed at least 97 per cent. of the larvae of *C. plumosus* within seven days at concentrations of 0·075 lb. per acre; trichlorphon killed 97·5 per cent. at 0·05 lb. per acre.

Hazeltine (W.). **Chemical resistance of the brown dog tick.**—*J. econ. Ent.* **52** no. 2 pp. 332–333, 3 graphs, 3 refs. Menasha, Wis., 1959.

In 1956, resistance to chlordane was reported in *Rhipicephalus sanguineus* (Latr.) in New Jersey, but γ BHC (lindane) applied to infested dogs at 0·045 per cent. gave control [*R.A.E.*, B **45** 81]. The investigations described were carried out to determine the approximate resistance to γ BHC and chlordane shown by field strains of the tick in the Dallas area of Texas. Large engorged females, collected less than 24 hours earlier, were placed in cheese-cloth pouches and dipped for 10 seconds in emulsions

containing 0·05 per cent. γ BHC or 0·5 per cent. chlordane; the excess liquid having been shaken off for 2–3 seconds, the pouches were emptied into a clean plastic dish. Absorbent paper marked with 15-mm. circles was put under the ticks after five minutes, and each tick was placed on its legs in the centre of a circle. Inability to move out of the circles in two hours was adopted as the criterion of death. The concentrations used were chosen because they were reported to have been effective in past years and could safely be used on dogs as dips. Controls were untreated, as emulsion without toxicant had been shown to have no effect. The method did not allow of determination of the exact degree of resistance, but the results indicated a broad range of susceptibility to γ BHC in the various populations, with some resistant and others not, and a fairly high and rather uniform degree of resistance to chlordane.

Goulding (R. L.) & Terriere (L. C.). **Malathion residues in the milk of dairy cows treated for horn fly control.**—*J. econ. Ent.* **52** no. 2 p. 341, 5 refs. Menasha, Wis., 1959.

The only insecticides recently recommended in the United States for the control of *Siphona irritans* (L.) on dairy cattle are methoxy-DDT (methoxychlor) applied as a 50 per cent. dust at one tablespoonful per cow [*R.A.E.*, B **42** 189; **48** 52] and sprays of synergised pyrethrins or two thiocyanates, Lethane and Thanite. As it is desirable that other insecticides involving no hazard of toxic residues in the milk should be available, an investigation was made of the residues to be expected from malathion dusts and sprays applied at intervals necessary for satisfactory control of *S. irritans* in Oregon. One herd received three successive hand applications of 4 per cent. malathion dust at 2 oz. per cow, administered when the average infestation of the herd reached 30 flies per side per cow; after a further 9 days, the average infestation again reached 30 and an application of a 0·5 per cent. wettable-powder spray at 1 U.S. gal. per cow was given, which remained effective for another 10 days. Run-off from the spray was considerable. Another herd received a single hand application of 10 per cent. malathion dust at 2 oz. per cow. Only two of nine samples of milk collected 12–60 hours after the treatments with 4 per cent. dust contained a detectable amount of malathion (0·01 part per million), but 0·5 p.p.m. was detected four hours after the application of the spray. The treatment with 10 per cent. dust also resulted in definite contamination (0·03 p.p.m. after 12 and 36 hours and 0·024 p.p.m. after 60 hours). Control effected by the three formulations was essentially the same, the deposits apparently remaining acutely toxic to *S. irritans* for only 4–5 days and the balance of the period of practical control being primarily a function of the potential of the fly population for recovery. Thus, control by hand application of 4 per cent. malathion dust, though practicable, was not so satisfactory as that afforded by a 50 per cent. dust of methoxy-DDT, which was effective for three weeks [**42** 189].

Loomis (E. C.). **A method for more accurate determination of air volume displacement of light traps.**—*J. econ. Ent.* **52** no. 2 pp. 343–345, 1 fig., 4 refs. Menasha, Wis., 1959.

Little attention has been given to the standardisation of the mechanical performance of suction traps for sampling insect populations, and with all the instruments hitherto used to measure air flow, the irregular velocity of the air flow across the discharge duct was a complicating factor. In this

paper, a description is given of an economical and easily constructed air tunnel by means of which the air flow through suction traps can be measured with satisfactory precision. It was designed for use with the American Model trap, which is a modification of the New Jersey light-trap [*R.A.E.*, B **23** 151; **31** 195], was described by T. D. Mulhern in 1953 and is now used throughout California for standard mosquito population measurement. The mean flow of air in linear feet per minute through 20 American traps tested with the air tunnels was found to be 287 and the median flow 300, with a range of 233–360. The effect of air flow on mosquito catches was tested in a room 6 ft. 9 in. long, 4 ft. 8 in. wide and 8 ft. high divided into two equal cubicles, in which several hundred reared adults of *Culex tarsalis* Coq. were liberated and in which traps differing in velocity of air flow were operated simultaneously for 12 hours. In each of five tests, a trap operating at 238 ft. per minute caught about twice or more than twice as many mosquitos as one operating at 113 ft. per minute. There was no significant difference in the sex ratio of the catches. As débris on traps can reduce air flow considerably, and traps operating at about half their maximum air-flow capacity have been seen in the field, it is evident that when standard samples are required the cleanliness of traps is as important as the equality of their air velocity ratings. Variation in voltage due to circuit overloading and nightly variations in wind velocity also affect air flow, but over these factors the investigator has little control.

Schmidt (C. H.) & LaBrecque (G. C.). **Acceptability and toxicity of poisoned baits to house flies resistant to organophosphorus insecticides.** —*J. econ. Ent.* **52** no. 2 pp. 345–346, 4 refs. Menasha, Wis., 1959.

Resistance to organophosphorus compounds in *Musca domestica* L. in Florida [*R.A.E.*, B **47** 85] was at first believed to be mainly physiological, but observations elsewhere indicated that behaviouristic resistance might also be involved [*cf.* **47** 26]. To investigate this, a laboratory study was made with radioactive baits and malathion-resistant flies from the Grothe colony, after 20 generations of selection for resistance to this insecticide [*cf.* **48** 123]. The baits consisted of dry sugar containing 1 per cent. malathion or trichlorphon (Dipterex) or, as controls, of sugar alone, and were mixed with sufficient phosphoric acid containing ^{32}P to give an activity of about 8 microcuries per g.; these were exposed, in amounts of 1 g. in small metal containers inside cylindrical screen cages, to batches of flies of one sex or the other, from the Grothe colony or a normal colony, that had been starved for 16 hours. The malathion bait killed 40 per cent. of the Grothe females, 77 per cent. of the Grothe males and all the normal flies. Only females were tested with trichlorphon, and all of both colonies were killed by it. No mortality was observed with the unpoisoned sugar. The amount of this taken by individuals of each colony ranged from 2·4 to 19·2 mg. per fly, with an average of 7·1 mg., whereas only a few of the surviving Grothe flies took as much as 2·4–4·8 mg. malathion-treated sugar; this indicates a general avoidance of malathion by this colony. Dead flies of both colonies had consumed only small amounts of bait, with a maximum of 2·4–4·8 mg. for the Grothe colony, and 1·2–2·4 mg. for the normal one; this does not indicate avoidance, as they probably died as soon as the lethal amount had been ingested, but it does not exclude it. Both physiological and behaviouristic resistance (avoidance) were involved in the survival of the Grothe females, for nearly half of the survivors took at least 0·6 mg. poisoned bait, as much as or more than that taken by some of the Grothe and normal females that died, which

indicates physiological resistance, but the rest took only 0–0·3 mg., which indicates behaviouristic resistance. None of the males showed such an extreme behaviouristic resistance. Some died after consuming small amounts, but all those that survived consumed at least 0·6 mg., an indication of moderate avoidance combined with physiological resistance. There was no indication of resistance of either kind to trichlorphon. The results are not completely comparable with those that might be expected in the field, where the flies usually have a choice of food and are not always hungry when exposed to the bait; the avoidance demonstrated would, therefore, be expected to be one of the factors contributing to the failure of baits in the field, though of less importance than physiological resistance.

Ware (G. W.) & Gilmore (L. O.). **Lindane in milk from sprayed cows.**— *J. econ. Ent.* **52** no. 2 pp. 349–350, 2 figs., 3 refs. Menasha, Wis., 1959.

The use of γ BHC (lindane) has been recommended in the United States for the control of mange mites [*Sarcoptes bubulus* (Oudm.)] on dairy and beef cattle, in two applications, separated by a fortnight, as a spray containing 1·5 lb. 25 per cent. wettable powder in 100 U.S. gal. water or in a single application at double this strength. Spraying may be carried out at a high pressure (250 lb. per sq. in.) or at a low pressure with a detergent to help saturation of the hair. The experiments described, which were made in February 1958 in Ohio, were designed to determine the effect of detergent in the spray on the contamination of milk. Two cows received 2 U.S. gal. of the weaker spray containing 0·04 lb. detergent and two others 1·5 U.S. gal. of a similar spray without detergent. The whole body was treated except the face and udder, and dosage was determined by the amount needed for adequate saturation. The concentration of γ BHC in the milk of all the cows was highest on the day after spraying, and diminished logarithmically with time. Some could still be detected in the milk of all the cows 17 days after spraying, and the presence of the detergent did not appear to affect the appearance of the γ BHC in the milk or its disappearance.

Smith (C. N.), Davis (A. N.), Weidhaas (D. E.) & Seabrook (E. L.). **Insecticide resistance in the salt-marsh sand fly** *Culicoides furens*.— *J. econ. Ent.* **52** no. 2 pp. 352–353, 7 refs. Menasha, Wis., 1959.

In Palm Beach County, Florida, satisfactory control of larvae of *Culicoides furens* (Poey) breeding in the tidal marshes and of *C. mellenus* (Coq.) breeding on sandy shores was obtained for 2–3 years by means of dieldrin-impregnated granules scattered from aircraft [*cf. R.A.E.*, B **44** 37–38]. By the end of 1957, however, *C. furens* was again causing annoyance and it appeared that the effectiveness of dieldrin against it was decreasing. An application of heptachlor-impregnated granules from aircraft in the autumn of 1957 gave little, if any, control, and the resistance of the larvae to various insecticides was studied in the laboratory in 1958. Samples of soil containing larvae were collected from a marsh in St. Lucie County, where there had been no treatment, and from one in Palm Beach County that had been treated three times with dieldrin (in April 1954, May 1955 and April 1957), once with malathion (in July 1956) and once with heptachlor (in November 1957), each time at the rate of 1 lb. per acre. Larvae were recovered by Bidlingmayer's method, dry beach

sand being used above the marsh soil [*cf.* **48** 66], and for testing, 25 were transferred to a beaker containing 5 ml. water, which was subsequently added to 95 ml. of a suspension or solution of the larvicide made by adding an acetone solution to water. Dead larvae were counted after 24 hours. Larvae from Palm Beach County were found to be more than 100 times as resistant to dieldrin, heptachlor, chlordane and γ BHC (lindane) and about ten times as resistant to endrin as those from St. Lucie County, but showed no resistance to DDT or organophosphorus insecticides (parathion, malathion and Bayer 21/199 [O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl phosphorothioate]). Dieldrin was the most effective larvicide against the normal strain, giving 94 per cent. mortality at 0·01 part per million, but caused no mortality at all, even at 0·1 p.p.m., of the resistant strain, of which parathion, DDT and malathion at the same rate caused 100, 94 and 86 per cent. mortality, respectively.

Lea (A. O.) & Lum (P. T. M.). **Autogeny in** *Aedes taeniorhynchus* **(Wied.).**—*J. econ. Ent.* **52** no. 2 pp. 356–357, 7 refs. Menasha, Wis., 1959.

Recent laboratory studies have shown that some females of *Aëdes taeniorhynchus* (Wied.) can develop a small initial batch of 10–20, or even 35–40, eggs without a blood-meal. To determine whether autogeny was of general occurrence in nature, biting females collected in the field in Florida were allowed to feed on a rabbit and induced to oviposit, and the amount of ovarian development in adults reared from their eggs and kept for 5–6 days without access to blood was determined. Autogenous females were found among these adults as well as among others that emerged in the laboratory from field collections of larvae and pupae, and the evidence of autogeny came from widely separated parts of the State. Autogenous and anautogenous females were reared from the same sod sample. It is not known whether the two forms interbreed, nor is there information as to whether members of the autogenous strain take part in the migration flight of recently emerged females [*R.A.E.*, B **46** 123] and if so, whether they soon drop out of the migration, thus conserving their food reserves.

Gless (E. E.) & Raun (E. S.). **Effects of chicken body louse infestation on egg production.**—*J. econ. Ent.* **52** no. 2 pp. 358–359, 1 graph, 3 refs. Menasha, Wis., 1959.

To investigate the effect of infestation of hens by *Menacanthus stramineus* (Nitzsch) on egg production, groups of five hens were placed in 24 cages, having been selected, as a result of the records of four weeks, so as to give pairs of cages showing similar egg production; ten lice were placed on each of the birds in one of each pair of cages and the numbers and weights of eggs laid were recorded for the next 14 weeks. No significant differences in the weights of the eggs were found, but infestation resulted in a reduction of 15 per cent. in egg production over the whole 14-week period, 26 per cent. during the last ten weeks and 84 per cent. in the 14th week. The infestation was not large until about the fourth week after the introduction of the lice, and the performance of the infested hens did not differ significantly from that of the uninfested ones until the 10th week. At the end of the test, two of the infested hens were dusted with γ BHC (lindane), and 24,627 lice were removed from one and 21,500 from the other.

Glasgow (J. P.), Isherwood (F.), Lee-Jones (F.) & Weitz (B.). **Factors influencing the staple food of tsetse flies.**—*J. Anim. Ecol.* **27** no. 1 pp. 59–69, 1 graph, 11 refs. Oxford, 1958.

The following is based largely on the authors' summary. Collections of gorged adults of *Glossina swynnertoni* Aust. and *G. pallidipes* Aust. were made on fly-rounds and at the resting sites of the flies [*cf. R.A.E.*, B **45** 186] at Shinyanga, Tanganyika, during February–December 1956, and the gut contents identified serologically [*cf.* **46** 206]. In all months, Suids were the most important group of hosts, and wart-hog [*Phacochoerus aethiopicus*] the most important host species. Suid blood was found in about 76 per cent. of the active males of *G. swynnertoni* (the group used in previous work [**46** 167]), in about 80 and 90 per cent. of the resting males and females, respectively, and in about 94 per cent. of *G. pallidipes* of both sexes. The conclusions reached in the previous work, which were regarded as biassed as they were based only on the active-male group, are therefore shown to be applicable to the population of tsetses as a whole. To explain the differences shown by the various groups, it seems necessary to postulate that *G. swynnertoni* and *G. pallidipes* exercise a definite preference for Suids. Although the general trend of this and the previous work [**46** 167] might suggest that Suids are always and everywhere the most important hosts of *G. morsitans* Westw. and *G. swynnertoni*, instances are given of areas in Tanganyika and Uganda where kudu [*Strepsiceros*], buffalo or hippopotamus appeared to be more important than Suids to *G. morsitans*. The use of bushbuck [*Tragelaphus*] as a major source of food by *G. pallidipes* [**46** 167] is also recalled, and these differences are presumed to be bound up with differences in the availability of the hosts.

Fitzsimmons (W. M.). **A new record of** *Anopheles maculipalpis* **Giles.**—*J. ent. Soc. S. Afr.* **21** no. 2 p. 426. Pretoria, 1958.

Anopheles maculipalpis (Giles), which had not previously been recorded from Nyasaland, was represented among species found during a mosquito survey begun in the late winter of 1957 in the Blantyre-Limbe Township area of the Southern Province. Breeding was taking place in September, at an elevation of 3,534 ft., in pools fed by slow-moving streams with little or no shade.

Senevet (G.) & Andarelli (L.). **Les moustiques de l'Afrique du Nord et du Bassin Méditerranéen. Les genres** *Culex*, *Uranotaenia*, *Theobaldia*, *Orthopodomyia* **et** *Mansonia*.—*Encycl. ent.* (A) **37** 383 pp., 79 figs., 11 pp. refs. Paris, P. Lechevalier, 1959. Price *Fr.* 4,000.

This is the first part of a survey of the Culicine mosquitos of North Africa and the countries of the Mediterranean basin, which it is proposed to complete in a further volume dealing with *Aëdes*. The structure of Culicine adults, larvae and pupae is indicated and figured, and the species of the five genera dealt with that have been recorded from North Africa and other Mediterranean countries are reviewed. Each is described in all known stages except the egg, and brief notes are given on distribution and breeding places, and generally on seasonal prevalence and anthropophily. There are keys to the adults, male hypopygia, larvae and in most cases pupae of the species dealt with, and, in a separate section of the book (pp. 321–365)

records are given of the distribution of the various species (with indications of the sources of the records) in countries and localities in North Africa, countries in Europe and Asia bordering the Mediterranean and Black Sea, islands in the Mediterranean and Atlantic, and countries of central and northern Europe.

Fox (R. M.) & Weiser (J.). **A Microsporidian parasite of** *Anopheles gambiae* **in Liberia.**—*J. Parasit.* **45** no. 1 pp. 21–30, 6 figs., 17 refs. Lancaster, Pa., 1959.

In the summer of 1956, infection with Microsporidia identified as *Nosema stegomyiae* invaded and spread rapidly through a well-established laboratory colony of *Anopheles gambiae* Giles in Liberia and also involved a colony of *A. gambiae* var. *melas* Theo. As oocysts of *Plasmodium falciparum* develop in the presence of such infection only when it is light, infected mosquitos cannot be used in malaria study, and both colonies had to be destroyed. A few infections with Microsporidia had been found during some thousands of midgut dissections of *A. gambiae* in Liberia between June 1955 and April 1956. The morphology of *N. stegomyiae* and the course of infection in adults of *A. gambiae* are described. Infection cannot be recognised by behaviour or external characteristics, but is immediately recognisable on dissection by the opaque chalk-white colour of the infected midgut which is invaded early. The parasites entered at the mouth, probably in contaminated food or water, and spread along the alimentary tract, then to the fatty and muscular tissues, ganglia, circulatory epithelium and gonads. Differentiated ovarian follicles were not invaded, so that mature eggs were free of the parasite, but the undifferentiated follicles became involved, with consequent follicular atrophy and reduced egg production. No infected larvae were found. Fumagillin, an antibiotic developed for use against *Nosema apis* in honey bees, was found to be too slow in action to be useful in treating infected mosquito colonies. The best control is prophylactic sterilisation of all cages and equipment and prompt destruction of infected batches of mosquitos.

Ascher (K. R. S.). **Reduced oviposition in** *Aedes aegypti* **L. following tarsal exposure to a fluorocarbon.**—*Experientia* **14** no. 1 pp. 8–9, 16 refs. Basle, 1958. (With a summary in German.)

A brief account is given of experiments on the effect on oviposition by *Aëdes aegypti* (L.) of tarsal contact with di(p-chlorophenyl)-trifluoromethyl-carbinol, which was recently shown to be able to reduce substantially or even inhibit oviposition by house-flies [*Musca domestica* L.] [*R.A.E.*, B **47** 66]. As continuous contact with the deposits increased mortality among the mosquitos or made them refuse to feed on blood, contact of short duration followed by a single blood-meal was the method used. Females 4–5 days old, taken from mixed populations bred from well-fed larvae and kept at 28°C. [82·4°F.] and 80 per cent. relative humidity and provided with 10 per cent. glucose, were exposed for 10–40 minutes at 24°C. [75·2°F.] to a deposit of the test compound at 1 g. per sq. metre on filter paper. They were then returned to 28°C., starved for 20–24 hours and given the opportunity to feed on guineapigs. Those that engorged were caged in small groups with equal numbers of males and provided with glucose solution and an oviposition surface. There was neither initial knockdown nor

significant mortality in 24 hours, nor was feeding inhibited or life shortened. The mean numbers of eggs laid per female by five groups of ten that were kept as controls or exposed for 10, 20, 30 or 40 minutes, were 61, 62·3, 47·2, 29·5 and 27·2, respectively. Corresponding figures for two series of groups of approximately 25 females were 59·6, 58·4, 52·3, 33·8 and 30·6 and 65·2, 62·8, 48·7, 35·1 and 36, respectively. When females were kept in individual cages, only 31 per cent. of those exposed for 30 minutes oviposited, whereas 77 per cent. of the controls did so.

Heisch (R. B.), McPhee (R.) & Rickman (L. R.). **The epidemiology of tick-typhus in Nairobi.**—*E. Afr. med. J.* **34** no. 9 pp. 459–477, 12 graphs, 7 refs. Nairobi, 1957.

About 20–30 Europeans are treated for tick typhus [*cf. R.A.E.*, B **39** 77–78, etc.] in Nairobi every year. Infection is probably acquired from ticks picked up from grass and other vegetation during walks or brought into houses by dogs. The epidemiology of the disease was studied locally in 1956–57, as it has never been fully worked out in East Africa. Over a period of one year, 4,435 ticks of ten species were collected, of which 1,696 were *Haemaphysalis leachii* (Aud.), 684 *Rhipicephalus simus* Koch, 319 *R. sanguineus* (Latr.), 556 *R. pulchellus* (Gerst.), 85 *R. appendiculatus* Neum. and 836 *Amblyomma variegatum* (F.). The first three species were often associated with dogs, and *H. leachii* and *R. simus* were frequently found in the burrows of two rodents, *Arvicanthis abyssinicus* and *Otomys angoniensis* [*cf.* **23** 262]. *Amblyomma variegatum* and *R. pulchellus* were common on cattle. Guineapigs were inoculated with suspensions of ticks of nine species, and nine strains of rickettsiae were isolated from *H. leachii*, one from *R. simus* and two from *A. variegatum*. Five of the positive batches of *H. leachii* were from dogs and cats, three from *Otomys* burrows and one from a leopard. The infective batch of *R. simus* was from dogs, and the two batches of *A. variegatum* from dogs and cows, respectively. No rickettsiae were isolated from *R. sanguineus* or *R. pulchellus* [*cf.* **23** 262; **39** 77], and evidence that the latter is ever involved in transmission in East Africa is considered unconvincing.

Twelve African volunteers were inoculated with rickettsiae, and one of them, who received a strain from *R. simus*, developed typical tick typhus. The rickettsiae were recovered from his blood. Several of the other volunteers showed varying degrees of pyrexia. Weil-Felix agglutination tests showed a marked rise in titre for Proteus OX19 in the sera of five of the volunteers and sometimes a smaller increase for OX2. Several of the volunteers were at least partly immune at the time of inoculation. The sera of 23 Nairobi dogs gave positive results in agglutination tests, titres for OX19 and OXK being generally higher than those for OX2. Attempts to isolate rickettsiae from three dogs with positive Weil-Felix reactions failed. The significance of the dog as a reservoir remains uncertain, but it is believed that it merely brings infected ticks into contact with man and does not act as a domestic reservoir as well. The sera of 24 individuals of *Arvicanthis abyssinicus*, 18 of *Otomys angoniensis*, two of *Rattus natalensis* (*Mastomys coucha*) and one of *Lemniscomys striatus* gave negative Weil-Felix reactions, but sera from three out of 12 of *Rattus rattus kijabius* agglutinated OX19 in titres of 1:120 to 1:240. Suspensions of brains and spleens of 84 individuals of *Otomys*, 30 of *Arvicanthis*, three of *Lemniscomys* and one of *Rattus* were inoculated into guineapigs, and one strain of rickettsiae was isolated from *Otomys* and another from *Lemniscomys*. The *Otomys* strain caused pyrexia in a human volunteer. Cross

immunity reactions showed that the various strains were closely related. The rickettsiae isolated all appeared to be of the type of *Rickettsia conori* [*cf.* **42** 143; **43** 76–77], and J. H. C. Gear concluded from complement-fixation tests that the strains from Kenya ticks and rodents were closely related to, if not identical with, strains causing South African tick-bite fever.

TETLEY (J. H.). **The sheep ked, *Melophagus ovinus* L. I. Dissemination potential.**—*Parasitology* **48** no. 3–4 pp. 353–363, 3 refs. London, 1958. **II. Keds acquired by a lamb from its mother.**—*T. c.* pp. 364–374, 5 graphs, 3 refs.

For direct dissemination, sheep keds (*Melophagus ovinus* (L.)) need to take up a position on the surface of the fleece from which they can easily transfer to another sheep that brushes against them. 'Dissemination potential', the subject of the first of these papers, is a term proposed for the percentage of the population that is on the surface of the fleece at any particular time. The rate of transfer depends on dissemination potential, which fluctuates on one host and varies from one to another, and the frequency of contact between hosts. The factors on which fluctuations in dissemination potential and opportunity for transfer largely depend, are the ability of animals other than sheep to serve as temporary hosts, the distribution and behaviour of the keds on sheep, the flocking of sheep, the nature of the fleece and the degree of contact of young lambs, weaned lambs, lactating ewes and rams with other sheep. Sheep are the natural hosts, and as they seldom have bodily contact with animals of other species, there are few records of keds from animals other than sheep. The favoured areas of infestation on sheep are the shoulder and underside of the neck, the sides and the breech [*cf. R.A.E.*, B **30** 32; **39** 200], and the females, in particular, do not travel far. The keds move through the fleece in depth, however, as they cannot survive for long at the high temperatures that develop at the skin surface on full-fleeced sheep. Sheep with dense or matted fleeces are less susceptible to attack than those with open, better ventilated wool, and those with greasy wool less susceptible than others. Young lambs usually acquire infestation from the mother while feeding. Rams distribute keds among ewes during the mating season and between themselves during fighting at all seasons.

Two rams in the off-breeding season, one with long, coarse, matted fleece and the other with shorter, finer, better ventilated fleece, were used in an investigation of direct dissemination in New Zealand. On four days, the dissemination potentials were 44·7, 16·6, 37·5 and 29·9 on the first animal and 30·6, 10·2, 21·3 and 15·9 on the second. Bright sunshine caused an increase in the dissemination potential, particularly on the first ram. It was concluded from the observations made that the stimulating factor was quickly rising temperature in regions directly exposed to the sun's rays and that the difference in dissemination potential between the two animals arose from the subjection of fleeces of different character to similar degrees of temperature change at the fleece surface. Male and female keds behaved similarly. Transfer from one ram to the other occurred readily, but when the two rams were kept together, and the keds were transferred at intervals from the one with a low dissemination potential to the other, so that the keds were concentrated on the one with a high dissemination potential, the combined population on the two declined rapidly, whereas when the direction of transfer was reversed the combined population increased. About half the keds leaving the sheep with a high dissemination potential did not

reach the other one. The former thus served to reduce over-all infestation. It is thought that the keds that were unaccounted for transferred to vegetation or other objects with which the sheep came in contact. Destruction of the keds by the host or birds is discounted as a significant factor.

In the observations described in the second paper, the rate at which young lambs acquire keds from the mother [*cf.* **47** 197] was studied on a spring-born lamb from the third to the 42nd day of its life. The lamb and its mother grazed in a paddock with a few other adult sheep infested with keds, and the keds on the lamb were counted daily and returned to the ewe from 19th September to 2nd October and at less regular intervals from then until 27th October. Counts were made on the ewe on 19th and 23rd September and 16th October when there were 263, 295, and 310 keds on it, respectively, the numbers on the lamb being 21, 33 and 36. Keds applied themselves closely to the skin of the lamb, many on the under, sheltered parts of the body that were not likely to come in contact with other sheep. The dissemination potential of keds on the lamb was accordingly very low, and it is concluded that transfer was almost exclusively from the ewe to the lamb; from observations on their behaviour it was concluded that, so far as hosts were concerned, there was an almost closed ewe-lamb system. The percentage of the population on a sheep that daily reached a second host was termed the dissemination index; it was, in the case of male keds, 14·4 from 18th to 25th September, 9·6 from 25th September to 2nd October and 3·8 from 2nd to 27th October; the corresponding percentages for female keds were 9·5, 6·8 and 4·6. This fall in the rate of transfer of keds to the lamb was attributed to declining frequency of contact between the latter and its mother, associated with the transition from a wholly milk diet to one in which pasture became progressively more important. The greater proportion of males than females transferred from the ewe to the lamb during the early part of the observations is attributed to the fact that the proportion of males is higher on the hind part of the body of the ewe, a region with which the lamb comes more frequently into contact. A higher ratio of males to females on the hind part of the lamb than on the front is explained by the tendency of males to migrate more through the fleece than do females. During the hours of darkness and some hours of daylight, few, if any, keds passed from the ewe to the lamb, the greatest numbers accumulating on the lamb during periods with many hours of bright sunshine and little rain. The running totals of keds acquired by the lamb more nearly paralleled the running totals of hours of bright sunlight than other meteorological factors. It is concluded that the connection was indirect and that sunshine raised the temperature of the fleece of the ewe, causing more keds to come to the surface and be available for transfer to the lamb.

Thomas (P. L.) & Watson (H. H.). **The occurrence in New Zealand of the northern poultry mite, *Ornithonyssus sylviarum* (Canestrini and Fanzago, 1877).**—*N. Z. vet. J.* **6** pp. 47–50, 14 refs. Wellington. N. Z., 1958.

An account is given of the history, habits and known distribution of *Ornithonyssus sylviarum* (C. & F.), which had not previously been recorded from the southern hemisphere but has now been identified on poultry on two farms near Christchurch, New Zealand. The mite has not yet been recorded from wild birds in New Zealand, but they may assist in its spread though they were probably not responsible for introducing it. Methods of control are suggested.

SKERMAN (K. D.). **The efficiency of new insecticides for control of the body louse of sheep** (*Damalinia ovis*) **by dipping.**—*Aust. vet. J.* **35** no. 3 pp. 75–79, 2 figs., 4 refs. Sydney, 1959.

The following is based mainly on the author's summary. Three experiments, each with 22–45 sheep in small groups, were carried out in Victoria to evaluate BHC as a suspension, aldrin, dieldrin, diazinon and malathion from emulsion concentrates and trichlorphon (Neguvon) in aqueous solution for the control of body lice (*Damalinia ovis* (Schr.)) by plunge dipping, the sheep being immersed individually in about 30 gal. fluid held in 44-gal. drums. Aldrin, diazinon, γ BHC and malathion used at 0·01 per cent., each eradicated body lice at a single treatment and protected against reinfestation for 16–20 weeks. Diazinon gave the longest period of protection. Aldrin and diazinon at 0·001 per cent. eradicated the lice at a single treatment and conferred protection for about 16 weeks. Diazinon at 0·1 per cent. protected for more than 32 weeks. In an experiment to determine minimum effective concentrations, dieldrin or diazinon at 0·0001 per cent. eradicated lice from lightly infested sheep at a single dipping, but the duration of effectiveness was not determined.

In a field trial with 877 sheep, body lice were eradicated by spray dipping with dieldrin or diazinon at an initial concentration of 0·005 per cent. in a spray dip that had a rectangular enclosure with fixed bottom sprays and oscillating overhead sprays. The concentration of each insecticide fell to about 0·002 per cent. at some stages of dipping, before readjustment.

KARTMAN (L.). **An insecticide-bait-box method for the control of sylvatic plague vectors.**—*J. Hyg.* **56** no. 4 pp. 455–465, 1 pl., 3 graphs, 19 refs. Cambridge, 1958.

The following is virtually the author's summary. Field trials were carried out in the San Francisco Bay region of California in 1956–58 to test the effectiveness of 5 and 10 per cent. DDT powder in rodent bait-boxes [*cf. R.A.E.*, B **45** 108] against fleas on native wild rodents and in the rodent nests. The principal species of fleas concerned were the known vectors of sylvatic plague, *Malaraeus telchinum* (Roths.) and *Hystrichopsylla linsdalei* Holland [*cf.* **48** 115, etc.], and the rodent was the meadow vole, *Microtus californicus*, an important plague reservoir. Preliminary trials with the bait-boxes showed that *Microtus* and other small native rodents would enter them quite readily and feed on rolled oats. About 90 g. of either 5 or 10 per cent. DDT powder, put on the floor boards of the bait-boxes, was picked up by the rodents and resulted in effective immediate control of all species of fleas on them, and control of all species on *Microtus* (with the possible exception of *H. linsdalei*) was obtained over a period of several months. Analyses of *Microtus* nests showed considerable amounts of DDT that had been transported to them by the rodents. All flea species in nests were effectively controlled by 5 per cent. DDT for at least 132 days after the DDT had been removed from the area.

ADOLPHI (–). **Examination of a pyrethrum synergist. Preliminary information.**—*Pyrethrum Post* **4** no. 4 pp. 3–5, 6 refs. Nakuru, 1958.

An account is given of contact tests against various species of insects and Peet-Grady tests against *Musca domestica* L., made to compare the effectiveness of octachlorodipropylether (for which the code name S 421

is used) with that of piperonyl butoxide as a synergist for pyrethrins. S 421 had been found to be no more injurious than piperonyl butoxide to rabbits and small rodents. In the contact tests, the two synergists usually gave combinations of about equal toxicity and S 421 showed some superiority against *Blatta orientalis* L., for which toxicant:synergist ratios of 1:4 and 1:9 were used. It is stated to have been associated with a more pronounced initial action than piperonyl butoxide in tests with mosquitos, but no particulars of these are given. It had given poor results in preliminary tests against *M. domestica* by topical application, but in Peet-Grady tests, in which the toxicant:synergist ratio was 1:10, its use resulted in much better knockdown and kill than did the use of piperonyl butoxide. It is concluded that S 421 seems to be particularly suitable as a synergist for pyrethrum sprays used indoors. Preliminary recommendations are given of formulations for concentrates for aerosol bombs including S 421 and also one for an emulsion concentrate. For space sprays against *M. domestica* and cockroaches, a solution of 0·02 per cent. pyrethrins and 0·1 per cent. S 421 in deodorised kerosene is recommended. A concentration of 0·2 per cent. pyrethrins and 1 per cent. S 421 in talc or another inert dust is recommended for trial against cockroaches and other crawling insects.

MAHONEY (D. F.). **Back-rubbers to kill buffalo fly.**—*Qd agric. J.* **84** no. 9 pp. 511–515, 3 figs. Brisbane, 1958.

The tests described in this paper indicated that cable-type back-rubbers, such as those used for the self-treatment of cattle against *Siphona irritans* (L.) in the United States [*R.A.E.*, B **40** 131; **45** 117, etc.], can be successfully used against *S. exigua* (de Meij.) in northern coastal Queensland, so that the drawbacks of a special muster in the difficult conditions of the wet season may be avoided. The method of preparing the 16-foot rubbers and of charging them with a 5 per cent. solution of DDT in oil is described. They were originally charged with one gallon and recharged fortnightly with half a gallon, but there were indications that recharging monthly with one gallon would do equally well. In the first trial, a rubber was hung between two posts [*cf.* **40** 131] near a water trough. Cattle that had used it since 29th November 1956 had averages of 1 and 14 flies per side on 8th and 27th February, respectively, whereas cattle that had no access to a back-rubber and were sprayed as often as was necessary in that period (three times) with 1 per cent. DDT had 15 and 24. In the second trial, under more normal paddock conditions, rubbers were fixed in January 1958 between trees so that one end of the cable was 5 ft. above the ground and the other 1 ft.; they were sited in shady places [*cf.* **47** 101] favoured by cattle during the wet season, and preference was given to trees that showed signs of constant rubbing by animals. Adequate control was maintained until 23rd April, when the trial had to be ended. Only negligible amounts of DDT were washed from the rubbers by heavy rain. Cattle without access to the back-rubbers were heavily infested.

SHANAHAN (G. J.). **Resistance to dieldrin and aldrin in *Lucilia cuprina* Wied.**—*J. Aust. Inst. agric. Sci.* **24** no. 2 pp. 157–158, 2 refs. Sydney, 1958.

Control of *Lucilia cuprina* (Wied.) on sheep on a property in central western New South Wales became unsatisfactory after aldrin (and some dieldrin) had been used there for three years. Adults of a strain established

from larvae obtained from this property were therefore tested by topical application of insecticides [*R.A.E.*, B **42** 118] for resistance. Dieldrin caused negligible mortality at less than 0·25 μg. per fly, 50–65 per cent. at 0·5–5 μg. and 80–100 per cent. at more than 5 μg. The LD50 for susceptible flies is about 0·025 μg., and the dosage-response data indicate that the field strain is heterogeneous towards dieldrin. Flies emerged from at least 75 per cent. of pupae of the field strain that had been immersed as prepupae in an emulsion containing 2 per cent. dieldrin, but none emerged from pupae of the susceptible strain immersed in one containing 0·05 per cent. Larvae of the resistant strain implanted on sheep treated one week previously with an emulsion containing 0·025–0·2 per cent. dieldrin established strikes, but all larvae of the susceptible strain died. Female flies of the field strain were about 50 times as resistant to aldrin as normal flies, the data indicating heterogeneity towards this insecticide also. The strain was not resistant to diazinon, and initial tests showed no pronounced cross tolerance to DDT or γ BHC.

Scott (M. T.) & Sinclair (A. N.). **Surface spraying and dusting for the control of ectoparasites of sheep. I. Preliminary trials on the control of the sheep body louse** (*Damalinia ovis*).—*Aust. vet. J.* **35** no. 6 pp. 288–292, 10 refs. Sydney, 1959.

Sinclair (A. N.). **II. Experiments with surface sprays and dusts to control the sheep body louse** (*Damalinia ovis*) **and the sheep ked** (*Melophagus ovinus*).—*T. c.* pp. 293–296, 2 refs.

Sinclair (A. N.) & Gibson (A. J. F.). **III. A comparison of the relative efficiency of surface spraying and jetting to control blowfly strike in sheep.**—*T. c.* no. 9 pp. 420–423, 13 refs.

To avoid the disadvantages of dipping for the control of ectoparasites of sheep (which include the danger of infection if it is done immediately after shearing, the cost of special mustering if it is delayed and the adverse effects of immersion in cold weather), two alternative methods of treatment have been evolved. These are dusting and the method known as surface or tip spraying in low-volume races [*R.A.E.*, B **47** 49, 183], which can be carried out immediately after shearing. The use of surface spraying is rapidly spreading in Australia and New Zealand, and dusting appears to be becoming established as an alternative in New Zealand [**48** 112]. These methods depend for their efficiency on the ability of certain insecticides to diffuse down the wool staple to the skin level [*cf.* **44** 89].

In the first of these papers, a description is given of preliminary trials in 1957 and 1958 in Victoria in which dusting and surface spraying were compared with jetting for the control of *Damalinia ovis* (Schr.). For surface spraying, the sheep ran at a rate of 30–40 per minute through a curtain of spray from 18 nozzles of 0·04 in. diameter, delivering a total spray quantity of 5 gal. per minute. During jetting, the sheep were held in the device for about 4 secs., during which they received about ½ gal. liquid from 14 nozzles of 0·052 in. diameter directed on to the back and 11 similar nozzles directed on to the crutch area. In dust treatments, the sheep passed at about 60 per minute through an apparatus adjusted to deliver 2·5–3 lb. dust per minute. Infestations of the louse were eradicated from small groups of sheep treated immediately after shearing with an emulsion containing 0·125 per cent. w/v dieldrin applied as a surface spray, 6 gal. of which was used on 57 sheep, with ½ gal. emulsion containing 0·025 per cent. w/v dieldrin applied individually as a jet or with 3 per cent. w/w dieldrin dust, 1·5 lb. of which was used on 54 sheep. Eradication was complete three

weeks after dusting, four weeks after spraying and six weeks after jetting. The same methods and concentrations failed to eradicate infestations on sheep carrying five months' wool at the time of treatment, though the louse populations were considerably reduced. Surface spraying with dieldrin 0·025 or 0·0125 per cent. w/v reduced but did not eradicate infestation on freshly shorn sheep. The concentration of insecticide in the emulsion collected after the sheep had passed through the surface-spray device was below that in the supply drums, and re-use was considered undesirable. Surplus sheep that were included in the treatments to make up workable batches received five successive applications of dieldrin, made by surface spraying twice at 0·0125, once at 0·025 and once at 0·125 per cent. and by dusting once over a period of two days without apparent ill effects.

In the second paper, the results are given of five field trials of dusting and surface spraying with dieldrin and diazinon for the control of *D. ovis* and keds (*Melophagus ovinus* (L.)) under various conditions of management and topography in New South Wales and Victoria, in which some 9,000 sheep were included. Freshly-shorn sheep were successfully freed from lice by surface spraying with 0·125 per cent. w/v dieldrin or diazinon, from keds by surface spraying with 0·25 per cent. dieldrin or diazinon and from both species by dusting with 3 per cent. dieldrin or 1·8 per cent. diazinon, though two living keds were seen after one month on one sheep dusted with diazinon. The results of treatment of sheep carrying several months' fleece, on the other hand, were inconclusive. Infestations of lice were eradicated from sheep carrying two or four months' fleece by dusting with 3 per cent. w/w dieldrin and from sheep carrying six weeks' fleece by spraying with 0·125 per cent. dieldrin, but not from sheep carrying four months' fleece by dusting with 1·8 per cent. diazinon; this last result is thought to be due to the use of an inadequate concentration.

Results are given in the third paper of a field trial made on more than 3,000 Merino sheep in northern New South Wales to compare the effectiveness against blowflies of jetting with emulsions containing 0·025 and 0·05 per cent. w/v dieldrin and surface spraying with an emulsion containing 0·25 per cent. w/v dieldrin. The sheep were jetted at rates ranging up to 360 per hour and surface sprayed at about 50 per minute. Jetting left a deposit of 0·5 or 1 g. dieldrin on specific areas of fleece and surface spraying deposited about 0·5 g. over the whole fleece. The period of complete protection against strike conferred by either method could not be accurately determined, as intense fly activity was not observed until some 6½ weeks after treatment. However, after complete protection had broken down, strike rates were ten times as high in the sheep that had been surface sprayed as in those that had been jetted. The implications of these results are discussed, and it is concluded that jetting, despite the slower rate of treatment, is the better method of controlling and preventing crutch strike of sheep. It is in any case doubtful whether surface spraying would be of use in the treatment of sheep already struck.

Micks (D. W.) & Singh (K. R. P.). **Infrared spectra of acetone extracts of susceptible and insecticide resistant strains of house flies.**—*Tex. Rep. Biol. Med.* **16** no. 3 pp. 355–362, 3 graphs, 9 refs. Galveston, Tex., 1958.

The following is based on the author's summary. The infra-red spectra of acetone extracts of a susceptible strain of *Musca domestica* L. and six insecticide-resistant strains were compared. All strains except the susceptible one and one that was resistant to Dilan [a 1:2 mixture of Prolan and Bulan], which showed a greater similarity in their spectra than

any other two, could be differentiated by comparison of the shape and depth of the narrow band from 2·7 to 3 μ and the shape and depth of the broad band from 7·8 to 10 μ, particularly that part with an absorption maximum at 8·6 μ. Differences between strains as to their absorption in this latter region appear to be due in part to their content of specific lipids, since there were no measurable differences in total fat.

The results thus far obtained indicate that although certain strains of susceptible and insecticide-resistant house-flies may be differentiated on the basis of subtle, reproducible differences in their infra-red spectra, these differences do not appear to be directly linked with resistance.

KEIDING (J.). **House-fly control and resistance to insecticides on Danish farms.**—*Ann. appl. Biol.* **47** no. 3 pp. 612–618, 1 graph, 10 refs. London, 1959.

Most Danish farms provide excellent conditions for breeding by house-flies (*Musca domestica* L.) as dung is allowed to accumulate outside the animal sheds, and published and unpublished information on 13 years' experience in the control of the flies under these conditions is here summarised and discussed. As the adults spend most of their time inside the sheds, control can be achieved by adequate treatment of these, and official recommendations for fly control with deposit insecticides were issued each year from 1946 onwards and largely followed. The same insecticide was thus used on a high proportion of farms, and few premises were left untreated. This led to the extensive development of resistance to chlorinated-hydrocarbon insecticides [*R.A.E.*, B **41** 123]. Contact sprays of pyrethrins with a synergist were then used as a supplementary measure, and though no specific resistance to pyrethrins developed, as the sprays were not used systematically, tolerance became 2–4 times as high as normal in populations with high resistance to other insecticides. Even a moderate level of resistance makes the use of pyrethrum insecticides uneconomic. When the chlorinated hydrocarbons failed completely, organophosphorus compounds were substituted. Gauze strips impregnated with parathion and hung under ceilings have been in widespread use since 1953. They were effective at first, but began to fail in 1955, and tolerance became 2–5 times as great and was sometimes 15 times as great where diazinon deposit sprays had also been used in the summer. Flies had therefore to stay much longer on the strips to acquire a lethal dose. They also appeared to become more sluggish and stayed mainly on the animals or the lower parts of the woodwork and walls. Diazinon when first used as a spray gave control for 4–10 weeks, but the LD50 had risen to 4–15 times the normal in 1954–55 and 15–30 times the normal during the summer in following years; its use was not recommended after 1957. Resitox (a wettable powder containing 20 per cent. Bayer 21/199 [O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl phosphorothioate]) was used on a thousand farms in 1955, and LD50's up to 500 times the normal were found after two months. Resistance to 21/199 could be induced in the field by the use of parathion and diazinon. A bait consisting when dry of sugar, a thickening substance and 6·5 per cent. trichlorphon (Dipterex), painted in stripes on places frequented by flies, gave good control when applied 3–5 times per season; resistance rose to only 3–4 times the normal in two seasons, though resistance up to 12 times the normal was found twice, in connection with high resistance to diazinon. In a search for insecticides other than nerve poisons, the most promising tried was thiourea. This was applied twice a week as a larvicide to the surface of the new manure on the dungheap at 25 g. per sq. m., in enough water to penetrate the upper layer in which the larvae live. However, as

treatment has to be very regular and the dung stacked with care, the method does not find favour, and thiourea was used only on a very limited scale in 1958.

When resistance to chlorinated hydrocarbons became general, their use was stopped in the hope of a reversion to susceptibility. In 1955, when DDT had been out of use for 5–6 years, BHC for 3–4 and chlordane for 2–4, practically all populations tested were heterogeneous as to resistance. Data on knockdown with DDT showed a segregation into a small resistant group and a relatively susceptible group. There is good agreement in Danish flies between resistance to knockdown and to kill. Similarly with γ BHC (lindane) and chlordane, almost all populations consisted mainly of moderately resistant flies with a few highly resistant and a few normally susceptible ones. Crossing experiments showed that resistance to DDT measured as knockdown is due to a single partly recessive gene [*cf.* **45** 213], the heterozygotes being rather susceptible and not clearly distinguishable from the susceptible homozygotes. Originally, the gene must have been deleterious, at least in the homozygous state, as it was very rare. While DDT was being used, it had a high survival value, and had the opportunity of making new and more favourable combinations with vital genes from the gene pool. This new integration of genes maintains it, at least in a heterozygous condition, when DDT pressure is relaxed even for several years. In 1958, fly populations from a district in which DDT had not been used for ten years showed as great resistance as in 1955. A similar development may have taken place with the genes responsible for resistance to BHC and chlordane, but inheritance of resistance to these compounds may be more complex. Strains of 60–80 times normal resistance to diazinon at the LD50 level lost tolerance steadily when kept without selection, until a level of about 8–10 times normal resistance was reached. A strain showing 15 times normal resistance at the outset still showed six times the normal tolerance after 45 generations without selection. As the results show that none of the strains was homozygous for resistance, it is remarkable that a complete reversion to susceptibility has not occurred. There have been several examples of a similar decrease in diazinon resistance on farms on which diazinon sprays have been replaced by parathion strips or trichlorphon baits for up to four years, but resistance did not fall below 4–7 times the normal on these farms or on others on which no insecticides were used in 1958. These observations suggest that resistance to diazinon, like that to DDT, will not disappear easily, but will survive at a moderate level, from which higher resistance, preventing effective control, can arise in a short time if diazinon is used again.

Wood (R. J.). **Insecticide resistance in mosquitoes.**—*Ann. appl. Biol.* **47** no. 3 pp. 620–625, 23 refs. London, 1959.

Since 1947, resistance to chlorinated-hydrocarbon insecticides has been demonstrated in 13 species of *Anopheles* and in species of *Culex*, *Aëdes* and *Psorophora* and to an organophosphorus compound (malathion) in *Culex tarsalis* Coq. [*R.A.E.*, B **47** 198]. On the other hand, in various parts of the world, susceptibility has persisted at its original level in many species of *Anopheles* even after several years of spraying with DDT. In those species so far investigated, resistance is transmitted by a single autosomal factor, which may be recessive [**47** 86] or show incomplete dominance [**45** 69]. G. Davidson, who has developed a method of determining the exact proportions of homozygous resistants, homozygous susceptibles and heterozygotes in field populations of *A. gambiae* Giles and *A. sundaicus* (Rdnw.) on

any particular occasion by the use of discriminating doses [**47** 86], has shown that a remarkably high proportion of non-susceptible individuals may be present even in an untreated population. Nevertheless, failure of selection in the laboratory to produce more than a slight increase in tolerance, which is lost when selection pressure is withdrawn, indicates that the initial population must be large for a high rate of tolerance to develop. Biochemical studies on resistance have been limited. An increased rate of metabolism of DDT to DDE in resistant strains has been found in several species, but no difference in BHC metabolism could be demonstrated in *A. gambiae* [**45** 86]. An observation in Persia of extremely low susceptibility to DDT in *A. maculipennis* Mg., when fat was developing prior to hibernation, suggests that chemical breakdown of the insecticide may not be the full explanation even of DDT resistance.

It has been suggested that, while resistance is developing under intensive selection pressure, other genetically associated characters as important as the resistance itself might also be selected, but the only clear-cut evidence of this from work on mosquitos is an apparent change in oviposition behaviour in a DDT-resistant strain of *Aëdes aegypti* (L.) in Trinidad. In 1954, an anti-larval campaign with DDT, carried out in Trinidad against *A. aegypti* after the appearance of yellow fever [**45** 100–101], failed to give the expected measure of control, and subsequent laboratory tests revealed a high level of physiological resistance [**46** 164]. Concurrently, Kellett & Omardeen reported a high rate of breeding in tree holes in the town of Arima. Although tree-hole breeding by *A. aegypti* may be considerable in Africa [**16** 70], it has generally been thought rare in America [*cf.* **13** 43–44], including Trinidad, but these authors found that 8 per cent. of the tree holes that were near dwellings and were above 6 ft. from the ground and contained water, and so were regarded as available for breeding, were being used. To determine whether the selective action of DDT has intensified tree-hole breeding in Trinidad, the influence on oviposition behaviour of the degree of illumination (chosen as the chief distinguishing character between tree holes and domestic water containers) was investigated in two DDT-resistant and two susceptible strains. The mosquitos were kept in cages divided by a partition, which left a ½-inch communication slit at the top, between the two halves. One half, representing the tree hole, was blacked out with cardboard; the only light to reach it was less than 0·02 lumen per sq. ft. at floor level and came through the connecting slit. The illumination in the light half was 6·5 lumens per sq. ft., produced from an artificial source and maintained day and night. Moist sugar-impregnated cotton-wool and a dish of water for oviposition were provided in both halves. The mosquitos were tested in batches of 40 females and 60 males. The females were allowed to engorge on a guineapig three days after emergence, and the eggs laid in the following week were collected daily and counted. In various experiments, females of the selected Trinidad strain (with larval resistance 2,500 times the normal), the Haiti strain (with a larval resistance 350 times the normal [*cf.* **46** 150]), an American susceptible strain and a normal strain originating from West Africa laid 63, 50·2, 17·4 and 30·3 per cent. of their eggs, respectively, in the dark side of the cage. The differences between either of the resistant strains on the one hand and either of the susceptible ones on the other were significant, whereas those between the Trinidad and Haiti and between the American and normal ones were not. It appears that there is a correlation between egg-laying in dark places and DDT resistance. This may be due to genetical association, which has, however, not yet been demonstrated, or it may be a rare instance of simultaneous physiological and behaviouristic resistance in the same insect population, phenomena which have generally been considered to be mutually exclusive.

Beckel (W. E.). **Observations on the rearing of larvae, pupae, and adults of some *Aedes* mosquitoes of northern Canada.**—*Canad. J. Zool.* **36** no. 5 pp. 797–808, 6 refs. Ottawa, 1958.

An attempt was made to find the optimum conditions for colonising species of *Aëdes* from northern Canada, and the following is based on the author's summary of the results. Tests of many variables showed that the larvae developed best when 100 were kept in Pyrex dishes in 350 ml. distilled water, changed every two days, with constant aeration, and were provided every two days with 50 mg. superfine dog food and 25 mg. yeast. The best temperature was 20±2°C. [68±3·6°F.]. Most of the experiments were carried out with larvae of *A. communis* (Deg.) collected in the field, but laboratory-hatched larvae of *A. hexodontus* Dyar and *A. campestris* D. & K. were used for some. An experiment in typical breeding places of *A. communis* showed that survival of larvae in their natural environment was much lower than in the laboratory, where over 60 per cent. of larvae generally pupated and over 50 per cent. gave rise to adults when conditions were optimal.

In experiments with adults, various mating stimuli and types of illumination and cages of different sizes, covered with copper screening or lined with white cloth, were compared. *A. communis* mated and produced fertile eggs when kept in 2×2×2 ft. screen cages and provided only with raisin juice as food. When the cages were lined with cloth, there was an increase in the number of eggs laid whether the cage was exposed to room light or illuminated from within, and with internal illumination of the cloth-lined cages, the percentage of females that laid fertile eggs was increased. The best results were obtained with a large, pyramid-shaped, cloth-lined cage, illuminated internally, but too few eggs were laid, even under the best conditions, to maintain a continuous colony. There was no successful mating and no fertile eggs were laid in cages containing adults of *A. hexodontus*, *A. nigripes* (Zett.), *A. excrucians* (Wlk.) or *A. campestris*; when bare human arms or guineapigs with shaved backs were offered as sources of blood-meals, none were taken, and even when individual females, enclosed in a small vial, were fed on the human arm, none of the eggs laid developed. About 3 per cent. of adult females of *A. communis* were parasitised by Mermithids [*cf. R.A.E.*, B **44** 135], and those with nematodes in their abdomens showed no signs of egg development.

Weintraub (J.), Rich (G. B.) & Thompson (C. O. M.). **Timing the treatment of cattle with Trolene for systemic control of the cattle grubs *Hypoderma lineatum* (de Vill.) and *H. bovis* (L.) in Alberta and British Columbia.**—*Canad. J. Anim. Sci.* **39** no. 1 pp. 50–57, 1 graph, 9 refs. Ottawa, 1959.

The following is almost entirely based on the authors' summary. Experiments on timing the oral treatment of calves for the control of *Hypoderma* larvae with Dow ET-57 (purified O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate) [*cf. R.A.E.*, B **48** 53, etc.] were carried out on ranches near Lethbridge, Alberta, and Kamloops, British Columbia, in 1956–57. Groups of 30 calves were treated once in November, January, March or April at Lethbridge and groups of 25 in December, January, February or March at Kamloops, the dose being 100 mg. per kg. body weight. The dates of treatment corresponded, respectively, with the presence of larvae of *H. lineatum* (Vill.) in the gullets, the appearance of larvae of *H. lineatum* in the backs of half the calves, the presence of the peak population of *H. lineatum* and the beginning of the appearance of *H. bovis* (Deg.) in

the backs, and the presence of peak populations of *H. bovis* in the backs. The treatments administered on the first three dates were about equally effective in controlling the larvae before they reached the skin of the back, mortality varying from 94 to 98 per cent. in the six groups, but treatment on the last date was ineffective.

There was no significant difference in mortality between *H. lineatum* and *H. bovis*, but, among the larvae of both species in the backs, those in the third instar were less affected than those in the earlier instars. Treatment in early autumn is recommended to avoid the presence of third-instar larvae and forestall early damage to hide and meat. Slight symptoms of toxicity, in the form of lethargy and reduced food consumption at Kamloops and ataxia of the hindquarters at Lethbridge, were observed in the calves treated in December and January, respectively, but they disappeared within 48 hours of treatment without the use of antidotes. The dosage used was lower than that reported in the literature to produce first symptoms of toxicity [**46** 89].

Weintraub (J.), Thompson (C. O. M.) & Qually (M. C.). **Low-level feeding of Trolene for control of the cattle grubs** *Hypoderma lineatum* **(de Vill.) and** *H. bovis* **(L.).**—*Canad. J. Anim. Sci.* **39** no. 1 pp. 58–63, 1 graph, 4 refs. Ottawa, 1959.

The following is substantially the authors' summary. Calves in Alberta were fed individually for 18 days in March 1957 on a ration of crushed oats treated with Dow ET-57 (purified O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate) to give a low daily dosage of 10 mg. per kg. body weight. This treatment killed 94 per cent. of the larvae of *Hypoderma lineatum* (Vill.) and *H. bovis* (Deg.) before they reached the backs and was not significantly different from a single treatment by boluses at 100 mg. per kg., which killed 97 per cent. [*cf.* preceding abstract]. The low-level treatment caused no mortality of larvae during the first week, but reached its full effect before the beginning of the third week. Of the larvae present in the backs at the time of treatment, 94 per cent. died and the rest pupated. The only symptom of toxicity to the calves was mild diarrhoea.

In a field experiment with free choice of feeding, two groups of calves had access to range blocks (containing 14 per cent. salt) that had been treated with ET-57. They consumed these at daily rates affording averages of 7·7 and 4·2 mg. ET-57 per kg. body weight for 93 and 64 days, respectively, from late November 1957, and the treatments resulted in 95 and 88 per cent. mortality, respectively, of the *Hypoderma* larvae before they reached the backs of the animals. By comparison, a group of calves, treated with boluses at 110 mg. ET-57 per kg. showed 80 per cent. mortality of larvae. The average numbers of larvae surviving the three treatments were significantly different from each other and from the untreated controls. All treatments were begun before larvae had appeared in the backs. No symptoms of toxicity were seen in the calves of the two groups receiving block treatment. Ataxia of the hindquarters was observed in the bolus-treated calves on the day following treatment, but disappeared on the same day.

Khan (M. A.), Thompson (C. O. M.) & Pelham (W. L.). **Co-Ral sprays for systemic control of the cattle grubs** *Hypoderma bovis* **L. and** *H. lineatum* **de Vill.**—*Canad. J. Anim. Sci.* **39** no. 1 pp. 115–120, 6 refs. Ottawa, 1959.

The following is almost entirely based on the authors' summary. Aqueous suspensions of 0·25, 0·5 and 0·75 per cent. (w/v) Bayer 21/199 (O,O-diethyl

O-3-chloro-4-methyl-7-coumarinyl phosphorothioate) in wettable powder were sprayed on Hereford calves in southern Alberta in December 1957 for the control of larvae of *Hypoderma lineatum* (Vill.) and *H. bovis* (Deg.) before they reached the backs of the animals. Two types of sprays were used, one prepared with anionic and the other with a combination of anionic and non-ionic surface-active agents. They were applied at pressures of 50 and 400 lb. per sq. inch, and when the lower pressure was used the spray gun was equipped with a hair rake to ruffle the hair. One gallon of spray per head was applied once to the backs and sides of each calf. Sprays containing 0·75 per cent. 21/199 reduced the number of larvae surviving in treated calves by 86 and 90 per cent., as compared with the number in the untreated group. There was no difference in larvicidal effects between 0·25 and 0·5 per cent. sprays, both of which reduced the number of larvae by 60–70 per cent. Neither the surface-active agents used nor the pressures employed had any effect on the larvicidal properties of the sprays. An ointment containing 4 per cent. 21/199 applied to the sides of the neck at 3 oz. per calf had no systemic effect on *Hypoderma* larvae.

None of the treated calves showed signs of organophosphorus poisoning, but there was an outbreak of a disease against which the calves had previously been vaccinated. The question is raised whether the stress of the sprays, which are cholinergic in effect, lowered the resistance of the calves to the disease.

Smith (H. J.). **A modified 2:4-dinitrophenylhydrazine (DNP) method for the determination of 'Pyrethrin I' and 'Pyrethrin II'.**—*J. Sci. Fd Agric.* **10** no. 5 pp. 260–267, 1 graph, 17 refs. London, 1959.

The following is virtually the author's summary. The method previously reported [*R.A.E.*, B **45** 88] for the estimation of 'Pyrethrin I' (cinerin I and pyrethrin I) and 'Pyrethrin II' (cinerin II and pyrethrin II) in pyrethrum preparations by the chromatographic separation of their 2,4-dinitrophenylhydrazones has been examined and modified to give a method suitable for the rapid analysis of pyrethrum preparations. Degraded (inactive) pyrethrins are eliminated, the results obtained being those for true (active) pyrethrins. The coefficient of variation of the analytical figures is less than those previously reported for methods involving a pre-analytical removal of degraded pyrethrins.

Skrŷnnik (A. N.). **The habitats and infection with spirochaetes of the tick *Ornithodorus nereensis* Pavl.** [*In Russian.*]—*Dokl. Akad. Nauk SSSR* **127** no. 1 pp. 230–232, 2 figs., 6 refs. Moscow, 1959.

Ornithodoros nereensis Pavl. was found in the Karakala region of Turkmenia in 1931 and shown to be able to transmit relapsing-fever spirochaetes [*R.A.E.*, B **32** 70]; it is known from no other region. In 1951, the author and co-workers collected some 5,000 ticks, both Ixodids and Argasids, there. They included 466 examples of *O. nereensis*, from nine burrows inhabited by tortoises and rodents, and some of these ticks proved to be infected with spirochaetes. In the laboratory, the ticks lived for up to five years. They could not be infected with spirochaetes derived from *O. tholozani* (Lab. & Mégn.) (*papillipes* Bir.), and seven other species of *Ornithodoros* could not be infected with spirochaetes from *O. nereensis*, although *O. nereensis* itself was readily infected with them and transmitted them. This suggested that the spirochaetes were specific to *O. nereensis*, and O. V. Smirnov named them *Borrelia* (*Spirochaeta*) *nereensis* in 1958.

In the autumn of 1958, the author carried out investigations near the village of Nere, not far from Karakala, and found ticks of the genus *Ornithodoros* in 53 of 260 burrows. There was a shallow rocky ravine near the village, with houses on one side of it and damp ground and some standing water at the bottom. Burrows inhabited by tortoises were common on the sides of the ravine, and 842 examples of *O. tartakovskyi* Olen. were taken in 24 of these, some of them attached to the necks of the tortoises. *O. nereensis* was found only twice in burrows of the usual type on the sides the ravine, but was common in cracks in damp soil beneath very large stones, where woodlice, which are not known to be associated with any other Argasids, also occurred, and all stages were found in 27 burrows beneath similar stones. Toads (*Bufo viridis*) were present in 11 of these burrows, 2–3 sometimes occurring in a single one, and most of the ticks in them were found in the neighbourhood of the toads; lizards were frequently seen outside on the stones. The ecology of *O. nereensis* [cf. also **34** 72] thus resembles that of *O. alactagalis* Isaakyan, which was first found in numbers in 1951 by the author and N. A. Filippova in burrows inhabited by the same toad on the sides of a ravine with a damp bottom in Azerbaijan [*cf.* **47** 62]; the two species are also similar morphologically. The numbers of *O. nereensis* per burrow varied from one to 400, and 2,826 nymphs and adults of both sexes were collected in all. No other Argasid was found, but Ixodids of two genera were occasionally present. *O. nereensis* sometimes attached itself to the arm while the burrows were being investigated, but the attack was less active than in the case of some other species of the genus.

The observations in the ravine indicated that species of *Ornithodoros* are closely adapted to special habitats. Within a distance of less than a kilometre, *O. nereensis* was found in burrows beneath stones, *O. tartakovskyi* in the burrows of tortoises, and *O. tholozani* in a single small cave at the bottom. The ticks could easily be transported from one habitat to another while attached to their animal hosts, but their distribution is evidently limited by microclimatic requirements and host habits.

In feeding tests with the ticks, 271 individuals of *O. nereensis* infected 6 of 9 white mice with spirochaetes, and 385 infected 5 of 6 hamsters (*Cricetus* (*Mesocricetus*) *auratus*), but guineapigs and toads (*B. bufo*) did not become infected. Feeding was completed in 1–1½ hours on all animals except the toads. The ticks remained on the latter for up to six days, and had to be collected from them on engorgement, since the toads ate any that they found crawling in the cage; this should be considered in any estimate of the part played by toads in the circulation of the spirochaetes in nature. The disease caused in the hamsters was severe. It lasted for about a month in both hamsters and mice, but more spirochaetes were observed in the blood of the hamsters, and one of the five that became infected died.

WALTON (G. A.). **Studies on** *Ornithodorus moubata* **Murray (Argasidae) in East Africa. Part I. Observations on distribution, food and climatic requirements in relation to relapsing fever as evidence of biological variation.**—*E. Afr. med. J.* **35** no. 2 pp. 57–84, 1 map, 24 refs. Nairobi, 1958. **Part II. Experimental and microclimatic evidence of biological variation.**—*T. c.* no. 3 pp. 107–136, 4 figs., 18 refs.

Most of the observations on *Ornithodoros moubata* (Murr.) and relapsing fever in East Africa that are the subject of this paper were described in an earlier account [*R.A.E.*, B **46** 26], but the present one contains additional tables of basic data, results of observations made in 1956 in Tanganyika,

in the hot arid areas south of Dodoma and the cool wet highlands of Uluguru mountain, and the preliminary conclusions drawn from an examination of biological variation in *O. moubata*, in which the number of forms recognised is raised from three to four.

Three of these four, referred to as A, B and D, are domestic forms occurring in huts, but the other, C, is a wild form, occurring in the burrows of porcupines (*Hystrix*) and wart-hogs (*Phacochoerus aethiopicus*) and in hollow baobab trees (*Adansonia*). Its distribution appears to extend from the southern Sudan southwards through northern Uganda to the eastern Belgian Congo, central Kenya, northern and southern Tanganyika, Nyasaland, Mozambique, Northern and Southern Rhodesia and possibly the northern Transvaal. It is active and exposes itself to bright sunlight when hungry, lays fewer eggs than form A, but more than form B and is extremely resistant to starvation, more than half the unmated females kept without food after their first meal being still alive after over four years.

Form A feeds on man, and its habits, habitat and distribution are those given for the form with a preference for human blood in the earlier paper, the isolated eastern pockets [**46** 27] occurring in the Jombeni Mountains, the Nyeri District and the Teita Hills above 4,000 ft. in Kenya and in the Usambara Mountains, the wet part of Ukerewe Island and Ngara and Bukoba Districts in Tanganyika. It is negatively phototropic and has comparatively little resistance to starvation, less than 50 per cent. of the starved unmated females being alive at the end of the first year and all being dead shortly after two years. Although only 1 per cent. infection with *Borrelia* (*Spirochaeta*) *duttoni* was found in ticks of this form, they are efficient vectors because of their feeding habits. They apparently cannot exist where wooden-frame bedsteads are used for sleeping [*cf.* **44** 129]. Form B apparently needs high humidity and feeds on fowls in huts in damp country, whether warm or hot. In such areas, large numbers can occur if fowls are numerous, even though the inhabitants all sleep on bedsteads. This form seemed to be more negatively phototropic and slightly more resistant to starvation than form A, over 70 per cent. of the unmated females being still alive a year after the first meal, and the last surviving for over three years. About 1 per cent. could infect rats with *B. duttoni* on inoculation, but the spirochaetes are not infective for fowls, and it is presumed that they were acquired during occasional feeds on man; as the chance that the same tick will feed twice on man is remote, this form is of no importance in the transmission of relapsing fever. Its area of distribution in East Africa appears to include the Digo and Embu Districts of Kenya, and the Usambara Mountains, Singida, the drier parts of Ukerewe District, the damper parts of Sukumaland and the Bukoba and Ngara Districts of Tanganyika.

Form D occurs in abundance, feeding indiscriminately on man and fowls, in huts in the vast tract of hot and arid country in central Tanganyika where rainfall is unreliable. It is considered the most important form in East Africa. Its greatest abundance corresponds with the highest temperatures and lowest relative humidities so far encountered in native dwellings in East Africa (86°F. and 43 per cent.). It occurs in greater numbers where fowls are absent. It feeds on man to a considerable extent, even in areas in which everyone sleeps on bedsteads, and may be presumed to be resistant to starvation and desiccation. However, since a high proportion may feed on fowls in some areas, the general level of relapsing-fever endemicity is low compared with that found in areas occupied by form A. Form D occurred in the Dodoma area, where the people live in long houses, often subdivided into family units, and sleep on the floor, and fowls are plentiful; tick infestation was the heaviest so far seen in

East Africa. A mean catch of 33 ticks was made in 95 per cent. of the housing units examined. There were more ticks in the absence of fowls than in their presence, and four times as many were associated with human sleeping places as with fowls, probably because the fowls ate considerable quantities, yet many ticks were found in places in which it was obvious that they fed on fowls. Avian blood was sometimes seen in ticks collected near human sleeping places and mammalian-type corpuscles in ticks from fowls' dust baths. The mean microhabitat temperature was 81·4°F., and five huts with a temperature of 85–86°F. had a mean infestation of 47 ticks. Relative humidity was low and was only 45–49 per cent. in the dwellings with most ticks. Relapsing fever was endemic. On Uluguru mountain, the range of microhabitat conditions at different altitudes resembled that experienced by form A in the Teita Hills in Kenya [*cf.* **46** 26], but the distribution of the ticks was reversed, there being none above 3,500 ft. but some in half the huts below that altitude, with a mean catch of 50 per hut. Fowls were present in nearly all the huts at the lower level and rather more than half those at the higher. It appears that the ticks can exist at 77°F. but not at 72°F., and possibly at a relative humidity of 71 per cent. but not at one of 76 per cent. In the south-eastern Lake Province there was evidence that as humidity values fall an increasing proportion of the ticks in huts can exist on the blood of man in the absence of fowls.

Forms A, B, and D appear to require four or five nymphal feeds for females and generally four for males, but C requires five or six for females and four, or more often five, for males. The females of forms A, B and D take about half an hour to complete their feed, and the secretion of the coxal fluid starts soon after the meal begins, lasting for about three-quarters of its duration; in form C the secretion of the coxal fluid is delayed and lasts less than half the period of the meal. The behaviour and appearance of the ticks during feeding affords a means of distinguishing the forms from one another.

Some results obtained by the crossing of domestic forms from huts with the wild form from burrows suggested (although the cultures used were not pure) that biological variations in one or other may be inherited or lost in the resulting hybrid offspring, and that these hybrids may acquire characters that make them unsuited to existence in the environment of one or other of the parent strains. Shape and biological differences in forms A, B and C are shown to be inherited by the offspring of pure lines of each.

Nelson (G. S.) & Grounds (J. G.). **Onchocerciasis at Kodera eleven years after the eradication of the vector.**—*E. Afr. med. J.* 35 no. 7 pp. 365–368, 9 refs. Nairobi, 1958.

Simulium neavei Roub. was eradicated from the Kodera district of Kenya in March 1946 [*R.A.E.*, B **35** 109–110]. A survey in 1957 confirmed that no transmission of *Onchocerca volvulus* had taken place in the intervening 11 years [*cf.* **42** 60], and young people previously found to be lightly infected had recovered spontaneously, but over 40 per cent. of the population over the age of 20 still had microfilariae in the skin and 76 per cent. still showed clinical evidence of onchocercosis.

Barnley (G. R.) & Prentice (M. A.). *Simulium neavei* **in Uganda.**—*E. Afr. med. J.* **35** no. 8 pp. 475–483, 3 figs., 1 ref. Nairobi, 1958.

Before 1947, onchocercosis [caused by *Onchocerca volvulus*] was known to be endemic in Uganda only in the area bordering the Victoria Nile

heavily infested with *Simulium damnosum* Theo., but subsequent surveys showed that it occurs in all the highland areas, which are drained by free-flowing perennial streams [*R.A.E.*, B **48** 9], and also in those parts of the lowlands in which forest canopy inhibits the growth of papyrus [*Cyperus papyrus*] even in comparatively sluggish streams, the Simuliid present in these areas being *S. neavei* Roub. Onchocercosis is absent only from the papyrus swamps, in which the species of *Simulium* that transmit it cannot be demonstrated. The adults of *S. neavei* are found in the forests or near their margins and the early stages in rivers shaded by forest, although in Kenya it is associated specifically with the crab *Potamon niloticum* [*cf.* **40** 5], which is confined to open stretches of fast-flowing rivers. Recent investigations in Uganda have been concentrated in the Budongo Forest east of Lake Albert and on the western slopes of Mount Elgon near the Kenya border.

In the former, an important timber-producing area, skin biopsies showed the presence of microfilariae in 78 per cent. of 250 labourers at the Budongo sawmills and all the permanent staff and 46 per cent. of students at the Foresty School. The forest lies in the centre of a belt of *S. neavei* that extends along the whole length of the rift escarpment northwards from the Ruanda-Urundi border. The adults were found throughout the forest and in the scrub at its margins, with the heaviest concentrations near centres of human activity. The immature stages developed in the comparatively small, heavily shaded streams that drain the forest area, in association with a crab referred to throughout the paper as *P. granviki* but stated in a supplementary note to be the closely allied *P. beradi beradi*. The streams have sluggish reaches and sometimes swamps that completely interrupt the carriage of insecticide suspensions [*cf.* **48** 35]. The range of *P. beradi* considerably overlaps that of *P. niloticum*, but the former species appears to be dominant in the upper reaches of the rivers where they flow in strips of undergrowth through cleared, cultivated land. Both crabs carried immature stages of *S. neavei*, over 50 per cent. of medium-sized individuals of *P. niloticum*, from rapidly flowing reaches of rivers in dense shade being infested, and 25–36 Simuliid larvae and 9–10 pupae being recorded on individual crabs. No other species of *Simulium* was found on either species of crab. A control scheme based on the application of DDT in water-miscible concentrate every ten days at one part DDT in two million parts water for 30 minutes was begun in November 1955 and continued for about three months, but populations of adult Simuliids had built up again within six months of the last treatment. A system of routine application of arbitrarily standardised doses at more sites every three weeks by the staff of the sawmills was then tried, and though satisfactory control of Simuliids was not achieved, no new cases of onchocercosis occurred.

On the south-western slopes of Mount Elgon, including the lower Manafwa valley, forest has been cut back to about the 7,000 ft. contour, rainfall is low and cultivation is sparse. Adults of *S. neavei* are thinly and sporadically distributed, *P. niloticum* carrying *S. neavei* occurs in the open, rapid stretches of the main streams [*cf.* **40** 5] and *P. beradi*, carrying *S. nyasalandicum* De Meillon, in the heavily overgrown reaches of small tributaries. The range of *P. niloticum* may extend $\frac{1}{4}$ mile upstream from the junction of the larger tributaries with the main streams. On the western slopes, however, the highest concentration of adult *Simulium* of any species so far met with in Uganda was found in the densely forested Namatala valley, *S. neavei* being caught at peak rates of over 200 per boy-hour. Yet, only the main stream of the Namatala with a dry-season flow averaging 16 cu. ft. per second provides the conditions considered necessary for *S. neavei* by McMahon [*cf.* **40** 5], and even in this stream *P. niloticum* is found only in the lower reaches. However, *P. beradi*

carrying early stages of *Simulium* occurs in all the numerous tributaries at least up to 6,500 ft. and up to the source of the smallest, which have free-flowing water only at the height of the rainy season. All Simuliids identified were *S. neavei*, *S. nyasalandicum* apparently being absent from the area. The percentages of individuals of *P. niloticum* caught in the most favourable habitats in the Manafwa river and of *P. beradi* in the Namatala system that carried larvae or pupae of *Simulium*, were 6 and 50, respectively. At a water temperature of 17·5–20·5°C. [63·5–68·9°F.], the larval stage of *S. neavei* lasted 30–41 days and the pupal stage 8–9 days. This was considerably longer than was expected. It is possible that measures to protect the crabs under observation from cross infestation produced an unnatural environment and interfered with the food supply of the larvae. Standardised doses of DDT suspension absorbed in mosquito-netting bags of vermiculite were introduced into the head waters to supplement gauged doses of 1 part DDT per million applied at over 140 points between 4th January and 17th April 1957, but control was unsatisfactory. Simuliid numbers decreased until mid-February but heavy rains then set in and there was no further reduction. However, in contrast to the experience in the Budongo Forest, there was no rise in numbers of either larvae or adults in the eight months after applications ceased, and it is thought that the flight range of the Namatala race of *S. neavei* may be very limited, the remaining population arising entirely from the small streams that were not dosed. Various species of Muscids (Coenosiinae) were observed to prey on feeding females, and when the count of Simuliids had fallen from about 200 to five per boy-hour, the predators almost outnumbered their potential victims, few of which fed to engorgement without being attacked. These predators may exercise considerable control on an artificially reduced population and be responsible for the slow rate of repopulation. Chemical control of the larvae in the deeply dissected well-watered forested areas involved would be a matter of the greatest physical difficulty and involve the use of a labour force beyond present resources.

Fredeen (F. J. H.). **Collection, extraction, sterilization and low-temperature storage of black-fly eggs (Diptera: Simuliidae).**—*Canad. Ent.* **91** no. 7 pp. 450–453, 5 refs. Ottawa, 1959.

An account is given of a method of collecting, separating, sterilising and storing Simuliid eggs that was devised in Saskatchewan to facilitate study throughout the year. Eggs that are laid in masses on objects at the water surface were usually easily found and collected, and those of species of which the females oviposit in flight were obtained either from the river surface or from the sand or mud of the river bottom; a plankton net was used for surface collections, but a shovel or dredge was needed for sampling the bottom. Eggs were usually transported to the laboratory in ice water. There, they were separated from dredged material by flotation in a solution of sodium chloride of 80 or 100 per cent. saturation, which had been found not to harm the eggs, even when they were exposed for up to one hour. After thorough dispersal of the dredged material in the brine, the floating organic material was passed through at least three sieves, of which only the bottom one was fine enough to retain the eggs. Fresh water was poured through until all salt had been washed out. The eggs of seven species were obtained in this way. The most effective and least harmful method of sterilisation was to soak the egg-masses in 5 per cent. sodium hydroxide for three hours. This had the effect of breaking up the masses, increasing percentage hatch and hastening embryonic development. It

also improved the keeping qualities during low-temperature storage. Embryonic development of several species continued at 3°C. [37·4°F.], but the eggs could be kept unhatched and viable for a long time at 0·5–1·5°C. [32·9–34·7°F.]. A large percentage of eggs of *Simulium venustum* Say remained viable for a year, but those of *S. vittatum* Zett. survived for a much shorter time, as would be expected, since the former species overwinters in the laboratory in the egg stage at 0°C. [32°F.], whereas the latter overwinters in the larval stage. Larvae and adults from eggs kept at these low temperatures did not differ noticeably in survival and vitality from those from freshly collected eggs.

O'Gower (A. K.). **The oviposition behaviour of** *Aëdes australis* **(Erickson) (Diptera, Culicidae).**—*Proc. Linn. Soc. N. S. W.* **83** (1958) pt. 3 pp. 245–250, 18 refs. Sydney, 1959.

The occurrence of the larvae of *Aëdes australis* (Ericks.) (*concolor* (Taylor)) in the Sydney area in salt-water sandstone rock pools [*R.A.E.*, B **25** 93–94] must be due to the influence of some factor of the environment other than salinity on the oviposition behaviour of the females, as Woodhill showed that the latter chose to oviposit in fresh water rather than filtered sea water [**30** 123–124]. Various environmental factors that might influence oviposition behaviour were therefore investigated and the results compared with previous findings with *A. scutellaris* (Wlk.) and *A. aegypti* (L.) [**44** 61; **47** 186; *cf.* also **48** 29]. The following is virtually the author's synopsis of the findings. The selection of an oviposition site by females of *A. australis* was influenced by the salinity of the water and by the physical properties of the surface of the water container, namely, its texture, its reflectance [**44** 61] and the presence or absence of free water. Fresh water was preferred to a range of salinities, a rough surface to a smooth one, lower reflectances to higher reflectances, and a moist, porous surface to a free water surface.

From a study of the interaction of these factors, it was concluded that the preference for a moist, porous surface over a free water surface so influenced oviposition behaviour in this species that texture, reflectance and salinity had little effect upon it.

Senevet (G.), Andarelli (L.) & Monpère (H.). *Aedes aegypti* **à Alger.**—*Arch. Inst. Pasteur Algér.* **36** no. 4 pp. 506–507, 3 refs. Algiers, 1958.

Aëdes aegypti (L.) was formerly considered the most plentiful house-frequenting mosquito in Algiers [*cf. R.A.E.*, B **28** 116], but it has recently become comparatively scarce and some workers have believed it to be disappearing from North Africa. To investigate this, records of determinations of 211 adults and 2,426 larvae made over a period of five years from various urban, surburban and occasionally rural areas in northern Algeria were examined. They did not include *A. aegypti*. Moreover, adult catches made in houses in Algiers by or on behalf of the author consisted exclusively of *Culex pipiens* L., and *A. aegypti* was not represented among 8,989 adults, 1,804 pupae and 28,954 larvae, principally from rural areas, identified for the anti-malaria service. However, larvae and adults of *A. aegypti* were taken on 30th September and 1st October 1958 in two cemeteries in Algiers, and it is assumed that the species is probably still present in most of the coastal towns of North Africa.

Christie (M.). **Predation on larvae of *Anopheles gambiae* Giles.**—*J. trop. Med. Hyg.* **61** no. 7 pp. 168–176, 6 refs. London, 1958.

An account is given of an attempt made in 1954–55, in the foothills of the Eastern Usambara Mountains in northern Tanganyika, to assess the effect of predators on the survival of larvae of *Anopheles gambiae* Giles in nature. Pairs of shallow, semi-permanent pools were dug in imitation of those from which the native population obtain water, and the normal fauna that developed in them was removed, as far as possible, by repeated use of a method of evacuation previously described [*R.A.E.*, B **44** 6–7], and Anopheline larvae were separated from it. The following is largely based on the discussion and summary. The remaining fauna of one pool of each pair was returned and a known number of first-instar larvae of *A. gambiae* introduced into both. Survival to the fourth instar in one series of experiments was 3 per cent. under natural conditions, 19 per cent. when a large part of the natural fauna had been removed but Notonectid nymphs were present and 58 per cent. when the fauna had apparently been removed. In a second series of experiments in older pools into which first-instar larvae were introduced daily and in which the populations of fourth-instar larvae and pupae produced were measured, removal of other fauna was very incomplete and survival to pupation, which appeared to be nil in pools with complete natural fauna, was 7–20 per cent. in the partly evacuated ones. However, the low survival was shown not to be attributable to overcrowding or unfavourable physico-chemical conditions and almost certainly not to disease and was presumably due to the action of the remaining predators. The studies demonstrated the great extent of predation but not the species responsible, and the various published methods of detecting the predators of mosquito larvae, such as the use of precipitin tests to identify stomach contents [**43** 198, 199] and of radioactive tracers [*cf.* **45** 95], have limitations. Notonectids are probably the most important. The results indicate that chances of survival for larvae of *A. gambiae* are low in well established bodies of water, the output of new females must be negligible in the dry season except in a few favourable localities, and breeding judged by eye to be heavy may not mean a large output of adults. Sites with a reproducing population of Notonectids may contain only a few early-stage larvae and are likely to be reported negative on dipping. Prospects of effecting biological control through the introduction of predators to breeding places do not appear encouraging.

Foote (R. H.) & Cook (D. R.). **Mosquitoes of medical importance.**—*Agric. Handb. U.S. Dep. Agric.* no. 152, [2+] 158 pp., 68 figs., 345 refs. Washington, D.C., 1959.

The basis of this work is a series of pictorial keys [*cf. R.A.E.*, B **45** 98, etc.] designed for separating the mosquitos of primary medical importance and their larvae in the 35 geographical regions into which the world has been arbitrarily divided for the purpose of the study. The species illustrated were selected for their importance as vectors of diseases of military interest, so that vectors of malaria, yellow fever, dengue and encephalitis were included, but not those of filariasis as such; a species was regarded as important when there was unquestionable evidence in the literature that it was a vector in a region or in regions bordering it. The extent of each region was determined in part by the number of medically important species that could be included on a single-page pictorial key. Information given for

each region, in addition to the keys, comprises the names of the countries or parts of countries included in it, brief notes on physical characters and climate, distribution of malaria and relative significance within the region of each of the important vectors included in the keys, together with a list, compiled from the literature and personal communications, of all the species of *Anopheles* reported from the region and discussions of other mosquito-borne diseases (yellow fever, dengue, various forms of encephalitis, certain other virus diseases and filariasis caused by *Wuchereria bancrofti* and *W. malayi*) and their vectors.

The main part of the book is preceded by an account of the various diseases and followed by notes on medically important mosquitos, in which published information pertaining to the bionomics, relation to disease and recorded distribution of each species is summarised. A short glossary of terms used is included.

Jewell (G. R.). **Detection of tsetse fly at night.**—*Nature* **181** no. 4619 p. 1354, 1 ref. London, 1958.

In January 1957, paints that fluoresce in ultra-violet light [*R.A.E.*, B **45** 53] were tested in the field at Shinyanga, Tanganyika, as a means of detecting *Glossina* at night. Individuals of *G. swynnertoni* Aust. were marked with such paints and released; 16 were observed, after dark on the same day, on leaves, all except two being on the upper surfaces. No flies could be found on the boles of trees or on the undersides of horizontal branches, where they had been seen at dusk [*cf.* **45** 186].

Rennison (B. D.), Lumsden (W. H. R.) & Webb (C. J.). **Use of reflecting paints for locating tsetse fly at night.**—*Nature* **181** no. 4619 pp. 1354–1355, 2 refs. London, 1958.

In an attempt to find a field method of detecting *Glossina* at night that would involve the use of less cumbersome equipment than is required to produce ultra-violet light [*cf.* preceding abstract], a reflective paint in the form of an aerosol and containing microscopic glass beads was tested. Spots of this 1 mm. in diameter could easily be seen on pinned flies at about 11 yards by the light of a 12-volt torch. As paint applied as an aerosol is liable to foul the flies, tests were made in the field in Uganda in which the beads were mixed with a gum-arabic solution containing a trace of detergent (Teepol). When 56 individuals of *G. pallidipes* Aust. were marked with spots of the mixture about 2 mm. in diameter and released, nine marked flies were detected at a distance of 9·5 yards, in the light of the torches. All but one, which was resting on a twig, were found on glabrous leaves at heights between 8 and 13 ft. above the ground. Although most of the marked flies were found near the release site, two were found at a distance of nearly 22 yards.

International Scientific Committee for Trypanosomiasis Research. Seventh Meeting, Brussels 1958.—*Publ. Comm. tech. Co-op. Afr. S. Sahara* no. 41, vii + 406 pp., illus., refs. [London, 1960.]

This publication contains the text of 44 papers submitted to this meeting, and the following are abstracts of those that deal with *Glossina* and the transmission of trypanosomiasis.

Smith (I. M.) & Rennison (B. D.). **Some factors concerned in trypanosome challenge** (pp. 63–66). The authors discuss the concept of trypanosome challenge [*cf. R.A.E.*, B **47** 41] and the work of Whiteside. He found that the greater the challenge the shorter the period of protection afforded to cattle treated with a prophylactic drug, proposed an index of trypanosome challenge, defined as the product of the apparent density of *Glossina* (number of non-teneral male and female tsetses per 10,000 yd.) and their infection rate, and showed that this can be used to plan a régime of prophylaxis for cattle in any given area, though it is not infallible. The authors consider a number of factors that must be taken into account in the estimation of trypanosome challenge. These include the hunger-cycle of the fly population, the extent to which different species of *Glossina* are attracted to different hosts, and the varying efficiency of different species of tsetse as transmitters of disease.

Weitz (B.). **The immunological approach to problems relating to trypanosomiasis** (pp. 71–78, 27 refs.). This paper includes a general account of the development of the precipitin and inhibition tests for the identification of the blood-meals of *Glossina* [*cf.* **46** 206, etc.].

Whiteside (E. F.). **The maintenance of cattle in tsetse-infested country. A summary of four years' experience in Kenya** (pp. 83–90, 3 refs.). Various aspects of the practical application of chemotherapy to the maintenance of cattle in tsetse-infested areas in Kenya are discussed. The factors concerned in trypanosome challenge [*cf.* above] are enumerated, and divided into those concerned with intensity of infection and those concerned with the characteristics of the trypanosome; the former comprise species and numbers of *Glossina*, their disposition to feed on cattle, the infection rate of the tsetses and mechanical transmission. Factors concerning the cattle themselves are classed as accessory.

Nash (T. A. M.). **The effect of different types of man-fly contact upon the distribution of *T. gambiense* sleeping sickness in Nigeria** (pp. 191–196, 4 refs.). Observations in Nigeria on the contact of man with *Glossina* in relation to sleeping sickness caused by *Trypanosoma gambiense* [**19** 13; **32** 134; **42** 154] are discussed, and a distinction is drawn between two forms of man-fly contact. The first is the close personal contact that is established in dry seasons after abnormally low rains, when *G. palpalis* (R.-D.) is virtually confined to the immediate vicinity of pools that never dry up, and near which African villages are sited. The second is the impersonal contact that arises in exceptionally mild years when water is abundant and *G. palpalis* ranges up and down the streams throughout the dry season. Then, although the tsetse population will be unusually large in the late dry season and man will be more frequently bitten at the water-holes, he will be bitten by different members of a shifting population and not, as in the first form of contact, by the few individuals that live beside the village water-hole and feed on the same people, day after day. Investigations have recently been carried out at two water-holes, one in southern Nigeria on the edge of the main forest belt at Ugbobigha [**48** 39], where sleeping sickness has never been known, and the other at Kaduna in Northern Nigeria, where sleeping sickness was formerly rife. Individuals of *G. palpalis* were caught, marked and released every day for a month, and throughout the following month the water-holes were kept under observation for marked flies and a note made of the proportions recaptured there 18 days (the minimal period required for the fly to become infective after having ingested blood infected with *T. gambiense*) or more after marking. The numbers of flies marked (given in brackets), and the percentages that were recaptured, at Ugbobigha and Kaduna, were 0·81 (371) and 7·52 (226), respectively, in the dry season and 0·55 (729) and 3·86 (1,942) in the wet.

Whereas in the south the chance of an infected fly remaining at the water-hole long enough to become infective is less than 1 in 100, in the north it approaches 8 in 100, and such a difference goes far to explain why sleeping sickness is found so rarely in the south. The incidence of sleeping sickness in West Africa in general can be explained if close personal man-fly contact is most intense in the northern savannah regions, and decreases as one approaches the main forest belt until the contact becomes entirely impersonal in the rain-forest; very high incidences seem to be mainly confined to areas with a prolonged dry season, and in the forest country the disease is usually confined to the drier mixed-deciduous forest, where the incidence is low, as in Ashanti [*cf.* **48** 43].

Southon (H. A. W.). **Night observations on *G. swynnertoni* Aust.** (pp. 219–221, 5 refs.). Observations, confirming and extending previous work [**48** 150, etc.], showed that *Glossina swynnertoni* Aust., in thorn bush near Shinyanga, Tanganyika, moved at dusk from diurnal resting sites on the undersides of branches to perch, with few exceptions, on leaves 1½–10 ft. above the ground, and returned to branch resting sites at dawn. The observations were made on 39 unmarked flies and 90 flies marked with microscopic glass beads applied to the tacky surface of a spot of artist's oil paint on the thorax of the fly, which then reflected the light of a 6-volt torch sufficiently to allow detection.

Welch (J. R.). **Variations with time of day in intensity of attack by *Glossina morsitans orientalis*** (pp. 223–225, 5 refs.). A diurnal rhythm has been shown to exist in the activity of *Glossina pallidipes* Aust. [**38** 105], and unpublished work by Ford & Culwick indicated that intensity of attack (*i.e.*, number of flies coming to the catching party, not always to feed) by *G. swynnertoni* Aust. was greatest in the morning and late afternoon and least during the hottest hours of the day. Two experiments to investigate diurnal rhythm in *G. morsitans orientalis* Vanderplank were carried out in *Isoberlinia-Brachystegia* wooded grassland near Kingolwira, Morogoro, Tanganyika, in an area in which the apparent fly density [**42** 152] was about 150. Three parallel transect fly-rounds [**47** 151], 200 yd. apart, taking 15 minutes to carry out and each divided into nine 50-yd. sectors, were traversed simultaneously by parties of two catchers. In one experiment, the rounds were done every 45 minutes, the first beginning 45 minutes after dawn or as soon as it was light enough to see the flies, and the last after sunset; three series were carried out, one in the early rains, another in the middle of the rains and the last in the cold dry season. In a second experiment, parallel series of catches were made, on the same rounds and using the same technique, at intervals of 30 minutes for a 4-hr. period that started at dawn in the first series and one hour later in each subsequent one, continuing until the last catch was carried out after sunset. In the two experiments, *G. m. orientalis* attacked at all times of day, but much less before sunrise and after sunset; there was some indication of a very slight diurnal cycle, with two peaks of attack, one in the morning and the other in the afternoon, but it was often overshadowed by other factors. Falls in temperature and saturation deficit led to intensified attack. In the second experiment, the first traverse of the round at almost any hour produced the maximum attack, which varied between 20 and 48 per cent. (average, 38) of the total 4-hr. catch, so that it represented rather less than half the flies available for attack in the area of the fly-round. The last two series of this experiment showed that attack ceased almost completely after sunset, but the catchers were bitten on several occasions while travelling in a truck in darkness. The author concludes that it would not be safe to move cattle in such an area even during darkness.

Bursell (E.). **The effect of partial feeding on the probing reaction of**

tsetse flies, in relation to trypanosomiasis challenge (pp. 227–229, 3 refs.). In view of the possibility that trypanosome challenge [**48** 151] may be affected by interrupted feeding by *Glossina*, a preliminary study of this phenomenon was made in the laboratory. When teneral males of *G. morsitans* Westw. were kept for 46 hours at 60 per cent. relative humidity and 26°C. [78·8°F.] and then allowed to feed on a man's arm, 90 per cent. would take a meal; feeding was interrupted at different stages of the meal, and the weight of blood taken was determined and expressed as a percentage of a normal meal, relative to the size of the fly as measured by its thoracic surface. The flies were then maintained as before and offered opportunity to feed again until they probed; the first opportunity was offered one hour after feeding, by which time the " primary " excretion of water had taken place and most of the blood-meal had passed from the crop to the midgut. Provided a fly had taken more than a third of its normal meal, it did not probe until that meal had been digested, but if less than this was taken, some of the individuals resumed probing, and if less than a tenth, the probing rate was not altered at all. Extrapolation of the data showed that, after a full meal, probing would be resumed after 3·5–4 days, which accords well with the hunger cycle recorded in the field at comparable temperatures [**43** 144]. Tests with flies at less than 30 seconds and at 1 hr. after an interrupted feed showed that, of flies that had taken less than a third of their normal meal, 61 per cent. probed after 30 seconds and only 43 per cent. after an hour. The difference was not significant, but the results suggest that inhibition of probing may be in part determined by distension of the midgut and that the propensity to probe may persist to some extent until the blood-meal has passed out of the crop. Flies that had had one blood-meal behaved in the same way as the teneral flies in similar tests. As cattle are not indifferent to the attentions of tsetse flies, it may be supposed that feeding by flies on them may be regularly interrupted, and trypanosome challenge may be far in excess of any value calculated from tsetse density and hunger cycle.

Cockbill (G. F.). **The use of records from traffic control points in Southern Rhodesia** (pp. 231–234, 1 fldg. table, 4 refs.). Pickets or traffic control barriers have long been used in Southern Rhodesia to restrict the carriage of *Glossina* on traffic to areas free of fly [*cf.* **18** 204]. These may consist of cleansing chambers, gates at which traffic is examined for carried tsetse and insecticide applied by means of hand-pumps, or pickets; they are situated on the estimated fringes of the tsetse habitat so as to reduce to a minimum the risk of traffic transporting tsetse into fly-free country and thereby causing outbreaks of trypanosomiasis in the cattle maintained there. Tests carried out in 1956 showed that when the number and size of vehicles were as large as those used on the main roads to the site of the Kariba dam, the cleansing chamber appeared to have reached the limits of its efficiency, in spite of improvements that allowed traffic to pass without awaiting capture of the flies. It was, however, found that the application of 4 per cent. BHC in dieseline as an aerosol from Swing-fog machines [*cf.* **44** 130] effectively cleared large lorries and trailers of tsetse flies in a few seconds. In Abercorn, catches from pickets that had been instituted primarily to prevent the spread of the fly were used, with more conventional fly-round catches, to demonstrate a decline in the tsetse population following anti-tsetse measures [**43** 89–90]. The author gives a similar instance with *Glossina morsitans* Westw. in the Urungwe Native Reserve, Southern Rhodesia, and quotes figures that show the close relation between catches of *G. morsitans* and *G. pallidipes* Aust. at control points in the Sabi valley and the incidence of trypanosomiasis in neighbouring cattle; he considers that such catches indicate the relative availability of the tsetse.

The catches of *G. morsitans* at all traffic points in Southern Rhodesia between 1952 and 1957 are summarised in a table; they totalled over 44,000 flies, of which 38·9 per cent. were females, and this percentage did not vary in different years or on different types of traffic. Cyclists collected more tsetses than did cars and both more than did pedestrians when leaving fly areas, but cyclists and pedestrians collected more than cars when approaching fly areas.

Lovemore (D. F.). *Glossina pallidipes* **Austen in Southern Rhodesia's northern tsetse belt** (pp. 235–236, 1 ref.). *Glossina pallidipes* Aust., which was first discovered in the northern tsetse belt of Southern Rhodesia in 1942 [**32** 24], has since been found so extensively as to indicate that it is almost as widespread there as is *G. morsitans* Westw. The failure to record *G. pallidipes* in the area for so long is discussed, and attributed to its general unwillingness to attack man, combined with the inaccessibility of the area and unavailability of bait animals, and possibly to its slower increase in numbers, after the reduction that followed the outbreak of rinderpest in 1896, compared with *G. morsitans*.

Ford (J.). **A note on the location of** *Glossina morsitans* **Westw. on transect fly-rounds** (pp. 237–240, 1 fldg. table, 5 refs.). The analysis of data from two transect fly-rounds [**47** 151], worked for 12 months in a belt of *Glossina morsitans* Westw. in Ankole, south-western Uganda, showed that significantly higher catches were made on the terminal sectors. This was because hungry tsetses, following the catching party [*cf.* **22** 25] from an area of high density, did not attack until the party had moved 150–400 yd., although several stops had been made. Fly-rounds therefore do not accurately reveal the distribution of tsetse flies at rest or prior to activation by the passage of the catching party, and it would seem that the aggregation of *G. morsitans* in its concentration sites or true habitat [**18** 240; **21** 198] is probably greater than would appear from data obtained in fly-rounds or reconnaissances, since it is likely that many of the flies caught outside such sites have followed the catching party, in spite of frequent stops for catching.

Goodier (R.). **Some effects of bush clearing in Southern Rhodesia** (pp. 241–245, 2 refs.). During 1957, a small reclamation scheme was undertaken against *Glossina morsitans* Westw., in the Urungwe district of Southern Rhodesia, in which bush clearing, followed by the settlement of Africans, was the method used. In the area concerned, only the riverine fringing vegetation of the Rengwe river, which forms part of the Umniati-Zambesi drainage system, was felled, between May and the end of August, and during the last month some 200 families moved in. A decline in fly numbers, ascribed to the onset of the cold season, had begun in April, but whereas the fly catches in two adjacent untouched areas remained steady during the period of observation, those in the area covered by the bush clearing continued to decrease, and no flies were caught there between the end of August and the end of October. It is suggested that this exceptionally rapid success of discriminative clearing [**44** 115] supports the view that ecological methods in the control of *Glossina* may be expected to have their greatest effect when applied in areas in which the climate is near the limits tolerated by the flies. The mean range of temperature in the cleared area was 27·2°C. [48·96°F.] and that in the uncleared 22·3°C. [40·14°F.], and the mean minimum during the period of the experiment 1·7°C. [35·06°F.] and 4·46°C. [40·03°F.], respectively; it is recalled that Burnett, in a paper previously noticed [**46** 165], recorded that exposure of *G. morsitans* to 2°C. [35·6°F.] for 2 hours caused more mortality than exposure to 4°C. [39·2°F.] for 4 hours.

Steel (W. S.) & Gledhill (J. A.). **The Broken Hill-Mulungushi Dam**

tsetse eradication scheme: 1941–1956 (pp. 247–267). A description is given of the history of an isolated pocket of the western race of *Glossina morsitans* Westw. [Vanderplank's typical race (**40** 142)], which occupied in 1951 some 60–70 sq. miles round the Mulungushi Dam, east of Broken Hill, in Northern Rhodesia, and the way in which this pocket became isolated from the main belt; it is now separated by only 15 miles from the tip of a westward advance of the eastern race [*G. m. orientalis* Vanderplank (**40** 142)]. Between 1946 and 1952, a combination of discriminative clearing [**44** 115] and game elimination, with subsequent settlement, gave initial success in the more marginal areas, but left residual pockets of fly in the more favourable sites. The discriminative clearing, based on visual inspection only, was not applied accurately enough to differentiate the more subtle variations of habitat on which the fly depended, and further reduction of the game was becoming increasingly difficult. A tendency is noted for the distribution of the fly in the secondary habitats to be masked in the initial stages of a campaign by the fly population from the primary and more obvious foci. As the result of an exhaustive survey in 1951, a scheme was evolved for the complete eradication of the fly by further discriminative clearing, to be finally assisted by application of insecticides from the ground; this was put into operation during 1952–54, and game elimination was suspended. The full-scale discriminative clearing carried out resulted in a marked reduction in numbers of fly caught, and a further reduction was effected by the application, during the latter part of 1954, of BHC in dieseline as a fog from a TIFA machine [**35** 128], mounted on a Land-Rover trailer driven at 2½–4 m.p.h.; preliminary trials during 1953 had shown this to be cheaper and easier to operate than the application of a DDT residual formulation. Five applications were made at intervals of 9–11 days between 10th August and 9th November; the time taken for individual applications varied between 7 and 12 days, and in all 12,135 gal. insecticide containing 3,600 lb. 30 per cent. γ BHC, were applied to areas of 18, 19, 23, 25 and 25 sq. miles, respectively. The applications were made between sunset and sunrise, the period when meteorological conditions were most favourable, and fogging was not carried out when the speed of the wind exceeded 8–10 m.p.h.; when the air was virtually still, and there was very strong air inversion resulting in the rapid drainage of the fog into dambos (seasonally swampy grasslands) and water-courses, the spray transects used were at 150-yd. intervals, but when there was a light breeze of 3–5 m.p.h. across the spray lines and a general inversion drift at right angles to the transects, the spraying interval was 300 yd. Fly catches during 1955 and 1956, over traverses totalling 2,280 miles, were 0·08 and 0·05 flies per 10,000 yd., some discriminative clearing having been carried out during 1955 in places indicated by the catches. Whether this density is below the threshold necessary for the continued existence of a fly population is not known, but the fly catches during 1957 remained about the same as in 1956, and a restricted application of a 3 per cent. dieldrin emulsion spray as a deposit insecticide was made in these areas. Immigation of fly from the eastern belt was demonstrated. A comparatively large-scale outbreak of bovine trypanosomiasis occurred in the area in 1954, while the campaign appeared to be progressing satisfactorily; there was no evidence that reinfestation of the area was the cause of the outbreak, and it is suggested that it was due to immigrant flies or to a sudden flare-up of a cryptic infection of long standing.

Esteves de Sousa (A.). **The use of phytocides to control stump and other secondary plant growth in areas cleared against** *Glossina austeni* (pp. 273–290, 3 maps, 10 refs.). An account is given of further experiments in Mozambique [*cf.* **47** 43], in connection with clearing operations against

Glossina austeni Newst. The best results were obtained when a mixture of the butyl esters of 2,4-dichlorophenoxyacetic acid and 2,4,5-trichlorophenoxyacetic acid, diluted with kerosene or diesel oil to contain the equivalent of 2·4 or 2·9 per cent. of each active acid was applied to stumps within 24 hours of felling, or when it was sprayed on natural thicket or regrowth from stumps 3–4 ft. high after dilution with kerosene so as to contain the equivalent of 1·5 per cent. of each active acid; the percentage of deaths or inhibition of regrowth was between 72 and 85 per cent. 9–10 months after treatment. The cost of treatment compared favourably with that of hand-cutting, which would have to be repeated every year or every other year.

Steel (W. S.), Gledhill (J. A.) & Norton (L. B.). **Chingola tsetse control scheme** (pp. 291–301). In 1952, a tsetse survey of the Copperbelt region of Northern Rhodesia showed *Glossina morsitans* Westw. to be firmly established in an area of woodland consisting mainly of *Brachystegia* and *Isoberlinia paniculata*, about 80 square miles in extent, lying west of Chingola, between the Kafue river and the Chingola-Solwezi road; occasional tsetses were found within a minimum area of 530 sq. miles but the true area influenced was undoubtedly much greater. Within the fly pocket, the main concentration was associated with a dambo and other major foci occurred on two rivers. A scheme for the eradication of the fly by discriminative clearing, to be followed if necessary by the use of insecticides, was drawn up, and fly pickets were established to prevent the carriage of the fly to neighbouring farms. The area was covered by 12 fly-rounds, each about 8 miles long, carried out weekly from early in 1953. The discriminative clearing of two major foci, which started in January 1953, showed by April 1954 that many subsidiary dambos, associated with ill-defined drainage areas, were playing an important part in the maintenance of the tsetse population, and these were cleared as the fly-round results indicated. Concurrently with the discriminative clearing, wood contractors for the copper mines made a barrier clearing along the eastern and southern flanks of the fly pocket, most of it situated outside the area of resident fly; judged by the early reduction in bovine trypanosomiasis on adjacent farms, this reduced the number of flies wandering or carried outside their normal ambits during 1954 and early 1955. By July, all the major foci, and the subsidiary ones that developed later, had been cleared, and discriminative clearing was terminated. As a result, 78 flies were caught in July 1955, as compared with 485 in July 1953. The eradication of the remaining flies by extension of discriminative clearing to increasingly more obscure sites was estimated to require at least another year, but the area infested had been reduced to a size suitable for control by insecticides. Five fog applications of a 1 per cent. solution of γ BHC in dieseline were made between 15th September and 18th November 1955 from a TIFA machine [*cf.* **48** 155]. As the fly population showed signs of increasing in March 1956, a restricted application was made in October and November to sites indicated by the catches, although only one fly had been caught during July–September; no more flies were caught in October–December and none was caught during check catches in the following dry season, when an increase would have been expected.

Weitz (B.), Langridge (W. P.), Napier Bax (P.) & Lee-Jones (F.). **The natural hosts of *Glossina longipennis* Corti and of some other tsetse flies in Kenya** (pp. 303–312, 10 refs.). The following is based almost entirely on the authors' summary. The blood-meals of 336 examples of *Glossina longipennis* Corti, 23 of *G. pallidipes* Aust. and 203 of *G. swynnertoni* Aust., captured in two areas in Kenya, were identified by the precipitin and inhibition tests [**46** 207]. The engorged flies were collected from their

resting places, and a valid sample of the fly population containing approximately equal proportions of males and females was thus obtained [*cf.* **48** 128]. *G. longipennis*, caught near a water-hole at Kiboko, between Nairobi and Mombasa, was found to feed mainly on rhinoceros [*cf.* **46** 167] and to a less extent on buffalo; the monthly percentages feeding on the first host during June–January ranged from 57·5 in March to 94·1 in August, and those on the second from 34·5 to 0 in the same two months. The fly seems to have a definite preference for these hosts. *G. swynnertoni*, caught in the Talek area, obtained more than half its food from wart-hog (*Phacochoerus aethiopicus*) [*cf.* **48** 128, etc.]. No flies had fed on zebra and only one (*pallidipes*) on waterbuck (*Kobus*), one (*swynnertoni*) on impala (*Aepyceros melampus*) and two (also *swynnertoni*) on hartebeest (*Alcelaphus*), topi (*Damaliscus*) or wildebeest (*Gorgon*) (which cannot as yet be distinguished serologically) although large numbers of these animals were present in both areas.

Page (W. A.) & Jordan (A. M.). **The economic importance of some West African species of *fusca* group tsetse flies** (pp. 313–314, 1 ref.). The dissection of forest species of *Glossina* collected from a block of high forest at Ugbobigha, in southern Nigeria [*cf.* **48** 39] showed the percentages of *G. tabaniformis* Westw., *G. fusca* (Wlk.), *G. nigrofusca* Newst. and *G. medicorum* Aust. infected with trypanosomes to be 3·5 in 2,722 individuals, 13·9 in 717, 26·3 in 124 and 15·5 in 103, respectively; the trypanosomes were *Trypanosoma vivax* and *T. congolense*, and the percentages of infections due to the first were 56, 77, 85 and 94, respectively. It is suggested that the low infection rate of *G. tabaniformis* may be associated with unusual host preferences [*cf.* next abstract], but this species is considered to be of little economic importance, since it is confined to the high forest where there is no grazing, whereas the other three species penetrate into the savannah in many localities from forest islands or riverine forest. The percentages of the females and (in brackets) of the males infected were 4·4 (2·1), 17·1 (11·1), 20·0 (11·0) and 24·0 (27·1) in 1,080, 414, 89 and 99 individuals of *G. tabaniformis*, *G. fusca*, *G. medicorum* and *G. nigrofusca*, respectively.

Jordan (A. M.), Page (W. A.) & McDonald (W. A.). **Progress made in ascertaining the natural hosts favoured by different species of tsetse** (pp. 315–317, 2 refs.). In investigations in Nigeria, the blood-meals of 109 individuals of *Glossina tabaniformis* Westw., 15 of *G. nigrofusca* Newst., 158 of *G. fusca* (Wlk.) and 41 of *G. medicorum* Aust., collected in high forest at Ugbobigha or at Olokemeji, of 186 individuals of *G. longipalpis* Wied. from savannah woodland adjacent to high forest at Ugbobigha, of 110 individuals of *G. morsitans* Westw. from the northern savannah and of 83 individuals of *G. palpalis* (R.-D.) from riverine vegetation in the northern savannah (within 90 miles of Kaduna) were identified by serological tests. The favoured hosts of each of the first six species, both in the forest and in the savannah, were either bushbuck (*Tragelaphus scriptus*) or the local species of pig (red river-hog, *Potamochoerus porcus*, in the forest, wart-hog, *Phacochoerus aethiopicus*, in the savannah); 73 per cent. of the feeds were from these animals, which are readily available and do not wander long distances, so that the flies, having digested their meal, readily regain contact with their hosts. There was no record of a meal having been taken from duiker (*Cephalophus*, *Sylvicapra* and *Philantomba* spp.), although these are the commonest antelopes and were previously considered to be important hosts. No tsetses of the *fusca* group were found to have fed on primates, reptiles or birds. Man, domestic animals and reptiles provided 74 per cent. of the meals of *G. palpalis*.

Wijers (D. J. B.). **The importance of the age of *G. palpalis* at the time**

of the infective feed with *T. gambiense* (pp. 319–320, 2 refs.). In an investigation of the difficulty experienced in infecting *Glossina* with trypanosomes, newly emerged adults of *G. palpalis* (R.-D.) that had not fed were offered feeds, singly, on monkeys infected with *Trypanosoma gambiense*; if a fly refused to feed on the first day after emergence, it was offered a further opportunity on the second day, and if it refused again, on the third day, and so on; after it had fed on the infected monkey, it was offered feeds on uninfected rats. From the 19th day after the feed on infected blood, the flies were tested daily by the probe method of detecting infection [**37** 137] until the 35th day, when those still alive were dissected. Of 343 flies that fed on the first day after emergence, 262 that fed on the second day, 146 that fed on the third day and 36 that did not feed until after the third day, 7·6, 1·1, 0 and 0 per cent., respectively, showed mature infections. In another experiment, in which 82 flies fed within 3–19 hours after emergence, 48 of them were alive after 19 days and 6 of these were subsequently found to have mature infections. There was little difference in infectivity between the males and females. These results suggest that infection is usually acquired soon after emergence, so that a single fly may infect many people, and they explain why epidemic sleeping sickness is found in Northern Nigeria in villages where only few of the flies caught at the water-holes are infected; support is also given to the belief that sleeping sickness must be mainly spread during the dry season [*cf.* **42** 154, etc.], since it may be expected that hot dry weather will stimulate the newly hatched fly to feed very soon after emergence.

Fraga de Azevedo (J.), Tendeiro (J.), de Almeida Franco (L. T.), Mourão (M. da C.) & de Castro Salazar (J. M.). **Les glossines de nouveau à l'île du Prince** (pp. 321–330). The contents of this paper on the reappearance of *Glossina palpalis palpalis* (R.-D.) in Principe have already been noticed [**47** 175].

Glover (P. E.), Le Roux (J. G.) & Parker (D. F.). **The extermination of** *Glossina palpalis* **on the Kuja-Migori river systems with the use of insecticides** (pp. 331–342, 4 figs., 7 refs.). The following is based almost entirely on the authors' summary. *Glossina palpalis fuscipes* Newst. has been exterminated from more than 300 miles of the Kuja and Migori river systems, an area in South Nyanza, Kenya, in which periodic epidemics of sleeping sickness, caused by *Trypanosoma gambiense*, have occurred. In the first phase of the operation, conducted in 1955, an emulsion spray containing 5 per cent. DDT was applied at fortnightly intervals from knapsack sprayers four times to vegetation along paths cut on both banks of the rivers. From January 1956 onwards, a similar spray containing 1·8 per cent. dieldrin [*cf.* **45** 105] was applied three times at three-weekly intervals, and, wherever reinfestation occurred, a knock-out dose of 5 per cent. dieldrin was applied. By October 1957, only three adults of *G. palpalis* were caught along more than 300 miles of river, and, by the end of June 1958, only one further fly had been taken. The numbers of cases of human trypanosomiasis treated, which had ranged between 107 and 157 a year between 1950 and 1954, fell to 66 in 1955 and to 16 in 1956; they showed a slight but insignificant rise to 21 in 1957.

Nash (T. A. M.), Page (W. A.), Jordan (A. M.) & Petana (W.). **The rearing of** *Glossina palpalis* **in the laboratory for experimental work** (pp. 343–350, 6 refs.). The authors describe a technique developed at Kaduna, Northern Nigeria, in 1950–58, for breeding *Glossina palpalis* (R.-D.) in the laboratory on a scale that required a stock of 3,800–8,000 flies, which made maintenance in tubes [*cf.* **42** 98; **47** 177] impracticable. The flies were kept in Bruce boxes with internal measurements of 6·1 × 3·1 × 2 in. and sides of cotton mosquito netting. The boxes were arranged upright

in wooden trays, 20 to a tray, in racks made of angle iron covered with hessian, in a room measuring 40 × 20 × 13 ft., which was ventilated by a fan that sucked air through a charcoal screen; wetting the screen allowed the air to be humidified and cooled. There was an exhaust fan at the other end of the room. The moisture of the air was supplemented by a humidifier [**41** 155], which operated when the relative humidity fell below 75 per cent. If the temperature fell below 25°C. [77°F.], convection heaters were automatically switched on. Further cooling and humidifying was effected by spraying the hessian coverings of the racks. The optimum conditions are believed to be a temperature of 25–26°C. [77–78·8°F.] and a relative humidity of 75–85 per cent. Use of the methods described gave a considerable degree of climatic control, but on days when the ambient temperature rose to 35°C. [95°F.] or over, the added moisture needed to keep the temperature below 28·3°C. [82·9°F.], above which very heavy mortality results, gave rise to excessive air humidity, and this, combined with the high temperature, was believed to be unfavourable.

The pupae were carefully removed through a hole in the end of the box and transferred to glass jars 3·3 in. high and 2·75 in. in diameter, the tops of which were covered with fine filter-cloth of spun rayon, secured by rubber bands; at the bottom, about 0·5 in. of dry sand covered the same material, which was attached by glue reinforced with a band of adhesive plaster. The jars were kept in mating cages about 1 ft. cube, with glass tops, mosquito gauze sides and perforated zinc floors, arranged over trays of wet sand that could be slid in and out. Only 200 pupae were kept in each jar, and emergence over 12 months from 33,000 pupae was 94 per cent. The tops of the pupal jars were uncovered daily and the newly emerged tsetses allowed to fly out into the mating cages, from which the females were removed singly in tubes, without handling, to small cages where they were held for three days, but the males were removed and marked by hand with red paint, to facilitate the separation of the sexes after the mating period, and kept for seven days before being used for mating. Mating was effected by placing up to 50 three-day-old females with twice as many potent males (at least seven days old) in the mating cage, which was left in fair light on a table in the fly-room for 5 hours (during which most mating occurs) and for a further 19 hours in one of the covered racks, where light intensity was low; by the end of this time, about 84 per cent. of the females were fertilised. After this treatment, the females were transferred in groups of 20 to Bruce boxes and maintained as already described [**43** 170]; at the end of 100 days, any survivors were destroyed, as the reproductive rate decreased with the age of the females [*cf.* **43** 171].

Feeding, originally carried out in a room without climatic control, was later effected in the fly-room, to avoid exposure of the tsetses to sudden changes of climate. All flies were allowed 15 minutes in which to feed on goats on every day except Sunday, when only freshly emerged flies were fed. The goats were used for a week and rested for two weeks, during which they were dipped twice in an arsenical and both flanks were rubbed with lanoline four times; goats treated in this way remained in good condition, some for as long as five years. Only goats showing no infection with trypanosomes were used for feeding the flies, and all were treated with antryeide. Dead flies were removed daily from the maintenance boxes, and daily mortality calculated; a rise in this from 2 to 4 or even 3 per cent. indicated something wrong; the mean daily mortality among the fertilised females from March 1957 to February 1958 was 2·4 per cent. The boxes were disinfected at about three-monthly intervals by soaking for 24 hours in 1 per cent. Centrimide, which has detergent as well as bactericidal

properties and no persistent smell, and for a further 24 hours in clean water; they were then hosed out, dried in the sun and finally autoclaved.

By the application of these methods, the average number of pupae obtained per female per month during the last eight months was 2·05, ranging from 1·9 to 2·1, but this still did not reach the figure of 3 needed to allow a substantial number of surplus pupae for research requirements, and the supply of the 8,000–13,000 laboratory-bred flies or pupae required annually necessitated supplementation of the females by collections from the field. Between March 1957 and February 1958 nearly 5,500 were provided from pupae deposited by captured females, and over 9,700 from pupae from the field; those produced from the fly-room totalled nearly 15,600. Very little help can be obtained from the first of the supplementary sources for six months of the year, and none at all from the second for about seven months, but it is desirable to bring new blood into the breeding colony throughout the year to avoid the production of an atypical strain of tsetse.

Foster (R.). **Some observations on the breeding of *Glossina morsitans* in the laboratory** (pp. 351–355, 8 refs.). The author reports the result of further work on the breeding of *Glossina morsitans* Westw., singly in tubes, in the laboratory [*cf.* **47** 177], giving comparative data for four colonies during the first 15 months of their establishment; two, (1) and (2), were kept at temperatures that showed diurnal variations of 74– and 76–80°F., respectively, and the other two, (3) and (4), at a constant temperature of 79°F. The flies in the first three colonies were given an opportunity to feed every third day. The mean life of the flies in (1) and (2) was about 40 days, as compared with 70 days in (3). Young flies survived better in (2) than in (1), the percentage of females surviving to reproductive age being 59 and 41, respectively, so that the percentages producing pupae were 38 and 27, and the mean numbers of pupae per female (including all females) were 1·2 and 0·8; in (3), the corresponding figures were 84 per cent., 61 per cent. and 2 pupae. In (4), the flies were offered an opportunity to feed every second day, and the corresponding figures were 92 per cent., 68 per cent. and 2·1 pupae, but this improvement in productivity was too slight to justify the increased work entailed. The flies tended to feed less often as their age increased, so that the interlarval periods became longer [*cf.* **47** 178] and the rate of pupal production declined; in colony (3) the number of pupae per week per 100 females reached a peak of 36 when it was seven weeks old and declined to 20 at 14 weeks and to 6 at 20 weeks. Flies emerged from only 65–75 per cent. of the pupae, which were kept in air of 60–70 per cent. relative humidity, and increasing the humidity usually reduced the proportion of emergences, which in no case exceeded 75 per cent. Constant feeding of flies on an individual sheep, which was the host of choice [*cf.* **47** 177], led to the refusal of many flies to feed further and to an inability to digest the blood-meal in those that did feed, so that frequent changing of the sheep used for feeding is advocated. Considerable differences in palatability between individual sheep were noted; 80–90 per cent. of the flies fed on some animals as compared with 40–50 per cent. of the same flies on other sheep. These differences did not appear to be related to the colour, age or external appearance of the sheep, or to the haemoglobin content or the cell counts of their blood.

Maclennan (K. J. R.). **The distribution and significance of *Glossina morsitans submorsitans* in Northern Nigeria** (pp. 357–365, 1 map, 11 refs.). The significance of *Glossina morsitans submorsitans* Newst. for the cattle economy of Northern Nigeria is emphasised, trypanosomiasis being the greatest single cause of loss to the cattle owner. The area known to be infested is given as one-fifth of the territory [*cf.* **46** 71] and is stated to

be increasing as survey progresses. Details of the distribution of this tsetse are given, and differences in its ecology in the Guinea and Sudan savannah zones of Nigeria are described [*cf.* **46** 71]. In the Sudan savannah zone, it prevents the use of well-watered river valleys that contain good grazing land and could accommodate a significant proportion of the cattle that are now forced into migrations of as much as 300 miles in search of sustenance in the dry season; in the Guinea zone, it is the major factor forcing the zebu cattle population to vacate wooded areas during the rains, even though riverine species have been controlled.

Wilson (S. G.). **Recent advances of** *Glossina morsitans submorsitans* **in Northern Nigeria** (pp. 367–389, 2 figs., 5 maps, 5 refs.). The following is based on the author's summary. Four northward advances of *G. morsitans submorsitans* Newst. that have occurred since 1950 in the Northern Region of Nigeria are described in detail. Three, those in the Song area of Adamawa province, in the Doka-Shika area of Zaria province and in the Kontagora area of Niger province, appear to have reached their maximum limits, but the fourth, in the Anchau-Banke area of Zaria province, has not. The factors that have influenced these advances during the past eight years are difficult to determine, but movements of human population, climatic factors and the easily available supply of food provided by herds of cattle grazed permanently near the limits of the fly-belts have all played a part; game movements have exercised only a very minor rôle.

van Asperen (K.) & Oppenoorth (F. J.). **Organophosphate resistance and esterase activity in houseflies.**—*Ent. exp. appl.* **2** no. 1 pp. 48–57, 1 graph, 5 refs. Amsterdam, 1959. (With a summary in German.)

The following is based partly on the authors' summary. Esterase activities were measured in homogenates of organophosphate-resistant and -susceptible house-flies (*Musca domestica* L.) of various origins. No differences were found in the cholinesterase activities, but aliesterase activity was much lower in the resistant than in the susceptible flies. It is concluded that resistance and low aliesterase activity are physiologically connected. It was previously postulated that, in addition to a cholinesterase splitting choline esters and acetic-acid esters but not acting on butyric-acid esters, house-flies also contained an aliesterase hydrolysing esters of butyric and acetic acid but inactive towards choline esters, the first being strongly inhibited by eserine and the second insensitive to it. Evidence, some of which is included in this paper, now indicates that there are at least two and probably more aliesterases present in house-flies.

Busvine (J. R.). **Patterns of insecticide resistance to organo-phosphorus compounds in strains of houseflies from various sources.**—*Ent. exp. appl.* **2** no. 1 pp. 58–67, 1 fig., 24 refs. Amsterdam, 1959. (With a summary in German.)

The following is based on the author's summary. Four strains of *Musca domestica* L. resistant to organophosphorus insecticides and a normal strain were maintained in laboratory culture. One of the resistant strains had been developed by laboratory selection, and the other three, originating in Italy, Denmark and the United States, by field usage of insecticides followed by laboratory selection, mainly by the use of parathion, diazinon and malathion, respectively. The ' resistance spectra ' of the various strains were examined by measuring their relative resistance to 14 organophosphorus

compounds in a micro-drop application test. The strains selected by exposure to parathion and diazinon showed rather similar resistance patterns, with highest resistance to parathion, paraoxon and diazinon and low resistance to malathion. The malathion-resistant strain showed high resistance to malathion and low resistance to parathion, paraoxon and diazinon. These two patterns are believed to reflect different resistance mechanisms. A detailed comparison of the two European strains showed more divergence in reaction to compounds containing an O,O-diethyl group, including parathion, paraoxon and diazinon, than to those containing an O,O-dimethyl group, including malathion. When the toxicants were injected into the back of the thorax, resistance of the laboratory and Italian resistant strains was less to parathion and much less to paraoxon than by the topical-application technique.

Wilson (F.). **A review of the biological control of insects and weeds in Australia and Australian New Guinea.**—*Tech. Commun. Commonw. Inst. biol. Contr.* no. 1, 10 × 7¼ in., v [+ 2] + 102 pp., 11½ pp. refs. Farnham Royal, Bucks., Commonw. agric. Bur., 1960. Price £1 5*s*.

This comprehensive review of attempts in Australia and Australian New Guinea (comprising the eastern half of New Guinea, the Bismarck Archipelago and Bougainville Island in the Solomon Islands) to control invertebrate pests and noxious weeds by biological means [*cf.* also *R.A.E.*, A **48** 368] is in three main parts. In the first is given, for each of 55 species or groups of invertebrate pests, information on all introductions of natural control agents and liberations of native beneficial species that have been made against them with, in some cases, lists of native natural enemies. The pests are mainly of agricultural importance, but include mosquitos, in both areas, and *Lucilia cuprina* (Wied.), *Siphona exigua* (de Meij.) and *Boophilus microplus* (Can.), in Australia. This part also contains a brief introductory section dealing with general papers relating to the biological control of insects, and a summary of the results obtained in both areas. In addition to lists of pest species of which the status has been reduced to varying degrees or not at all following liberations, with the control agents concerned, and one of pests against which natural enemies have been introduced but are not known to be established, it includes a discussion of the criteria by which the success of biological control operations should be judged. The second part is devoted to weed control. The third part includes discussions of the relative success against exotic and native pests; the sources of the beneficial species that have become established; the use of diseases, of native natural enemies and of introduced natural enemies other than insects and disease organisms; the regular or periodic liberation of natural enemies from laboratory stocks; and the factors that have prejudiced the success of attempts at biological control.

Dauterman (W. C.), Casida (J. E.), Knaak (J. B.) & Kowalczyk (T.). **Bovine metabolism of organophosphorus insecticides. Metabolism and residues associated with oral administration of dimethoate to rats and three lactating cows.**—*J. agric. Fd Chem.* **7** no. 3 pp. 188–193, 7 figs., 11 refs. Easton, Pa., 1959.

The following is virtually the authors' summary. Dimethoate is active as a systemic insecticide for cattle. Three lactating cows were treated orally with the radioactive compound, and analysis of blood, tissues, excreta,

and milk showed dimethoate to be rapidly metabolised and excreted. Twelve days after treatment, the insecticide was found in trace amounts only in the cow tissues. Hydrolysis of dimethoate by rats and cows occurred initially at the methyl-phosphate, phosphate-sulphur, sulphur-carbon, and particularly at the carbonyl-nitrogen bonds. Phosphorothioate oxidation occurred with certain of the hydrolysis products and was assumed to occur also with dimethoate.

Krueger (H. R.), Casida (J. E.) & Niedermeier (R. P.). **Bovine metabolism of organophosphorus insecticides. Metabolism and residues associated with dermal application of Co-ral to rats, a goat, and a cow.**—*J. agric. Fd Chem.* **7** no. 3 pp. 182–188, 6 figs., 17 refs. Easton, Pa., 1959.

The following is based partly on the authors' summary. Bayer 21/199 (O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl phosphorothioate), otherwise known as Co-Ral, was synthesised from ^{32}P-containing material and applied to the skin of rats, a cow and a goat at 30–45 mg. per kg. body weight. The animals were killed at predetermined intervals, and the tissues were tested chromatographically for residues of the insecticide. The methods used and the results obtained are discussed in detail. The rats were observed for 28 days, and much of the amount applied to them was excreted in the urine and faeces; four metabolites were detected in the urine. The goat was killed after six days, and the cow after eight weeks. No symptoms of poisoning were noted in either animal, and there were no pathological changes attributable to the compound. It is concluded that the latter is rapidly absorbed and undergoes the same metabolic changes as similar phosphorus insecticides, but that complete degradation occurs more rapidly than with them.

Pfadt (R. E.). **Fall dusting to control the sheep ked.**—*J. econ. Ent.* **52** no. 3 pp. 380–382, 5 refs. Menasha, Wis., 1959.

Although the sheep ked (*Melophagus ovinus* (L.)) can be eradicated from sheep in Wyoming by power dusting with 1·5 per cent. dieldrin after shearing in spring [*R.A.E.*, B **46** 83], a 5 per cent. dust was needed in autumn, when the wool is longer and dirtier, ked populations are increasing and low temperatures tend to keep them near the skin. Eradication was also effected in autumn by diazinon at 5 per cent. but not by 1 per cent. diazinon or 3 per cent. dieldrin, which effected reductions of 88 and 95–98 per cent., respectively, at similar rates of application, or by 1·5 per cent. aldrin or by 5 per cent. Co-Ral (O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl phosphorothioate), dicapthon, Korlan (O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate) or malathion, though Korlan, the most effective of these, gave 94–98 per cent. control. Hand-dusting tests also indicated that keds were harder to eradicate in autumn than in spring [but *cf.* **48** 17]. Of the six dusts tested in this way at both seasons, at 1 oz. dust per lamb and 2 oz. per ewe in spring and 2 oz. per sheep in autumn, 1·5 per cent. dieldrin, 5 per cent. malathion and 5 per cent. Korlan gave complete or almost complete control of keds on all occasions. Since the dust is worked into the fleece in hand dusting, poor penetration could not be the cause of reduced effectiveness in autumn. Dilution of the insecticide by the greater amount of wool and by dirt or grease is believed to be the chief factor.

Webb jr. (J. E.). **A study of insecticide resistance in house flies of Germany and France.**—*J. econ. Ent.* **52** no. 3 pp. 419–421, 4 refs. Menasha, Wis., 1959.

Strains of *Musca domestica* L. from five areas in Germany and four in France were tested in the laboratory to determine their susceptibility to DDT and, with the exception of one of the French strains, to γ BHC (lindane), dieldrin and malathion, the insecticides being applied topically in acetone solution. The strains, which were derived either from flies collected in the field in 1956 or 1957, or from larvae collected in 1957, were reared in the laboratory until several successive generations had been tested. All strains showed significant (at least 5-fold) resistance to DDT at the LD50 level, those from Heidelberg, La Rochelle, Orleans and Munich having LD50's 71, 44, 36·7 and 29·7 times as great, respectively, as that given by Decker & Bruce in a paper already noticed [*R.A.E.*, B **42** 54] for their non-resistant strain, for which the LD50 was 0·33 μg. Five strains showed a moderate degree of resistance to γ BHC and dieldrin, 5–17 and 9–33 times those of the non-resistant strain, for which the LD50's were 0·03 and 0·02 μg., respectively. None was significantly resistant to malathion in comparison with the most susceptible of Byers, Wheeler & Blakeslee's strains [**45** 146]. In spite of the considerable resistance found to DDT, γ BHC and dieldrin, field experience shows that adequate control of *M. domestica* with proper application of DDT or γ BHC is still possible in most areas of Germany and France. Malathion should prove effective where an alternative is required.

Harris jr. (E. D.), Genung (W. G.) & Chapman jr. (H. L.). **Comparison of two systemic insecticides and dates of application for cattle grub control in the Everglades.**—*J. econ. Ent.* **52** no. 3 pp. 425–428, 3 graphs. 8 refs. Menasha, Wis., 1959.

Hypoderma lineatum (Vill.) was first recorded as a pest of cattle in the Everglades area of Florida in 1953–54 and has since been increasing in numbers there. Animals with encysted larvae in the back have been noticed in every month except June, though they are less numerous in summer than in winter. Experiments were made in 1957 to compare Dow ET-57 (O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate) and Bayer 21/199 [O,O-diethyl O-3-chloro-4-methyl-coumarinyl phosphorothioate] for control and to determine the best time for treatment. Bayer 21/199 was applied along the back as a 2·5 per cent. spray, prepared from a wettable powder, at 11·25 g. toxicant per animal, but Dow ET-57 was given as a drench, as it is ineffective when applied dermally. The drench was prepared from an emulsion concentrate and administered at 5 g. actual toxicant per 100 lb. body weight. The dates of treatment were 6th May, 5th June, 8th July, 22nd August or 16th September, and the average weight of the animals was about 360 lb. at the beginning of the season and 560 lb. at the end. Between 11th October 1957 and 9th April 1958, each animal was examined at fortnightly intervals for encysted larvae. The peak of infestation among the 25 control cattle occurred on 15th January, when there was an average of 18·1 encysted larvae per animal. The peak among 50 cattle treated with ET-57 occurred on 12th February, when there was an average of 0·87 larva per animal over all batches. The infestation among the 50 animals treated with 21/199 was never more than 0·11 per animal, and there was no true peak. This insecticide was significantly more effective

than ET-57 when used in May–August, but the latter was significantly the more effective in September. The June application of ET-57 was significantly less effective than those made in the other months. It seems desirable to kill the larvae as soon as possible after they have entered the animal, but not to apply the insecticide earlier than necessary, so as to take full advantage of its persistent effect.

Burns (E. C.), Tower (B. A.), Bonner (F. L.) & Austin (H. C.). **Feeding Polybor 3 for fly control under caged layers.**—*J. econ. Ent.* **52** no. 3 pp. 446–448, 1 fig., 4 refs. Menasha, Wis., 1959.

Since the addition of 924 parts borax per million parts larval medium has been reported to cause 50 per cent. mortality of larvae of *Musca domestica* L. [*R.A.E.*, B **35** 55], investigations were undertaken to determine whether the droppings under caged laying hens could be made sufficiently toxic to effect larval control by the inclusion of Polybor 3 (containing 98 per cent. disodium octaborate tetrahydrate) in the hens' food at a level that would not result in the deposition of boron in the eggs or tissues. Five groups of hens received food containing 0·05, 0·1, 0·2, 0·3 or 0·5 per cent. Polybor 3 for about five months, and house-fly eggs were introduced at intervals into the droppings. Complete or almost complete control of fly emergence was given by Polybor at the two highest rates, but there were adverse effects on egg size and production and on food consumption, and boron was found consistently in the eggs, the amount increasing from 0·8–2·4 parts per million for the lowest rate to 7·8–17·7 p.p.m. for the highest one. Boron was also found in the tissues of the hens at the end of the period, though in small amounts except at the higher rates of administration.

Cole (M. M.), LaBrecque (G. C.) & Burden (G. S.). **Effects of gamma radiation on some insects affecting man.**—*J. econ. Ent.* **52** no. 3 pp. 448–450, 8 refs. Menasha, Wis., 1959.

The results are given of investigations carried out at Orlando, Florida, on the amount of γ-radiation from radioactive cobalt (^{60}Co) required to kill certain insects affecting man. The LD50's for all stages of *Pediculus humanus humanus* L. and *Musca domestica* L., nymphs and adults of *Periplaneta americana* (L.), *Blattella germanica* (L.), *Cimex lectularius* L. and *Thermobia domestica* (Pack.) and workers and queens of an ant (*Monomorium pharaonis* (L.)) ranged from 130 r for eggs of *Musca* 12 hours old to 190,000 r for nymphs of *Pediculus* and queen ants, and varied inversely with the size of the insect. Doses required to cause complete mortality ranged from 600 to 250,000 r. Effect on reproduction [*cf. R.A.E.*, B **44** 104, etc.] was studied in *P. humanus*; females exposed to 75,000 r or more in the nymphal stage laid no eggs, but when they were exposed to 50,000 or 10,000 r, some eggs were laid; when these rates were applied to nymphs of the first and second instars, most of the eggs hatched, but when they were applied to those in the third instar, only 9–16 per cent. did so. Some females survived exposure as adults to all rates from 10,000 to 150,000 r long enough to lay eggs, but none of these hatched. Lice of a Korean strain highly resistant to DDT [**46** 168] were no more resistant to γ-radiation than a normal strain.

Jones (C. M.) & Matsushima (J.). **Effects of ronnel on control of cattle grubs and weight gains of beef cattle.**—*J. econ. Ent.* **52** no. 3 pp. 488–490, 8 refs. Menasha, Wis., 1959.

The following is largely based on the authors' summary. An examination was made in Nebraska in 1956–57 of the effect of ronnel [O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate], when administered orally, on the infestation of young beef cattle with larvae of *Hypoderma lineatum* (Vill.) and *H. bovis* (Deg.) and consequently on their weight. The rates of administration were 100–110 mg. per kg. body weight in boluses or 92–99 mg. per kg. in drenches prepared from an emulsion concentrate or wettable powder. Boluses were administered to calves about three weeks before the larvae began encysting, and the average number of larvae that encysted in these animals was 0·5, as compared with 8·6 in the untreated ones.

The drenches were administered when the calves showed an average of three encysted larvae; those prepared from the emulsion concentrate failed to kill more than 10 per cent. of the latter, whereas the wettable powder gave complete mortality. The average number of additional larvae that encysted was about three in the first case and less than one in the second. The untreated animals showed an average of about 20 encysted larvae. Both species of *Hypoderma* were present. There were no significant differences in weight due to control.

Flemings (M. B.). **An altitude biting study of** *Culex tritaeniorhynchus* **(Giles) and other associated mosquitoes in Japan.**—*J. econ. Ent.* **52** no. 3 pp. 490–492, 1 fig., 4 refs. Menasha, Wis., 1959.

The biting habits of the vectors of Japanese [B] encephalitis and other associated mosquitos were studied at Sagiyama, Japan, from 4th July to 3rd October 1956, with particular reference to the heights above the ground of nests containing susceptible young birds. Aerial cage traps modified from the cages of Magoon and Bates [*R.A.E.*, B **33** 96–97, etc.] were used and were baited with black-crowned night herons [*Nycticorax nycticorax*]. These herons, which with plumed and great egrets [*Egretta intermedia* and *E. alba*] nest in the area at heights of 10–50 ft., are known to be reservoirs of the virus and preferred hosts of *Culex tritaeniorhynchus* Giles, the mosquito considered to be the principal vector of the disease in Japan [*cf.* **40** 163]. The traps, each containing two young herons, were operated for 24 hours a day three days a week at five heights ranging from ground level to 50 ft. *C. tritaeniorhynchus* was caught at all levels, but numbers were overwhelmingly greater at ground level than above and decreased with increasing height. Catches of *C. pipiens* L. and *C. bitaeniorhynchus* Giles suggested the same trend. *Armigeres subalbatus* (Coq.) was collected at ground level only, and other species taken were not in sufficient numbers to warrant consideration. On the ground, there were many young herons and egrets that had fallen from the nests before they could fly.

Dow (R. P.). **A method of testing insect traps and attractants, and its application to studies of** *Hippelates pusio* **and** *Culex tarsalis*.—*J. econ. Ent.* **52** no. 3 pp. 496–503, 3 figs., 13 refs. Menasha, Wis., 1959.

A method developed to compare baits for attractiveness to *Hippelates pusio* Lw. has also proved useful in investigations on *Culex tarsalis* Coq., both in the study of avian hosts [*R.A.E.*, B **47** 96] and in the evaluation

of different traps. The basic feature is the slow rotation around a central point, at a fixed radius and in a horizontal plane, of identical traps containing different baits, or of different traps containing identical baits. Two types of apparatus have been constructed. One used for *H. pusio* is essentially a low turntable, and carries vertical traps surmounted by inverted collecting jars [**47** 172]. The other, designed for work on mosquitos, has a central support and radiating arms from which cylindrical traps were suspended horizontally. Both were rotated at about one revolution in five minutes. The advantage of the method lies in the reduction of the effect of site differences. When, in accordance with a Latin-square design, each bait is tested in each trap in a multiple-period test, it is possible, by analysis of variance, to evaluate separately the effects of baits, traps, and periods of tests. If one element (baits or traps) is found not to make a definite contribution to total variance, other experimental designs become available.

Use of rotary testing in Georgia has shown that, upon exposure to air, liver bait becomes more attractive to *H. pusio* over a period of 1 or 2 days, that exposure to air does not increase its attractiveness to *H. bishoppi* Sabrosky, that bait that putrefies under aerobic conditions is more attractive to *H. pusio*, though not to *H. bishoppi*, than bait matured anaerobically, and that liver bait was more attractive to *H. pusio* than a bait of raw egg in water. Liver bait diluted with extra water was less attractive than undiluted bait to both species. The fact that captures of *H. bishoppi* were not affected by the way in which the bait was matured is considered to indicate that the bait contains two quite different attractants. A bait specific for *H. pusio* would be very useful as there is no rapid method of analysing collections that contain a mixture of both species.

In tests of traps for *C. tarsalis* in Utah and California, solid carbon dioxide, in double carton containers that dispersed the gas at a very uniform rate, was the source of attractant. Larger traps were found to be better than smaller ones, and none of several types of baffle was found to improve on a round entrance at the apex of an inwardly directed cone of wire screening, as, although traps with baffles of the Egyptian type [**33** 97] caught more mosquitos, they also allowed more to escape.

Drummond (R. O.). **Texas field tests for the control of cattle grubs with sprays of Bayer 21/199.**—*J. econ. Ent.* **52** no. 3 pp. 512–513, 2 refs. Menasha, Wis., 1959.

To determine whether the good results obtained with sprays of Bayer 21/199 (O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl phosphorothioate) against *Hypoderma* larvae in carefully controlled experiments [*R.A.E.*, B **46** 165; **47** 138] could be reproduced under a wide variety of field conditions, single or repeated treatments with power sprayers were tested in Texas on cattle on two ranches near Kerrville and three near Spur. At Kerrville, five treatments with a spray containing 0·75 per cent. wettable 21/199 and applied at 1–2 U.S. gal. per animal between February and July 1957, completely prevented encystment of larvae, and one treatment with a 0·5 per cent. spray at 1·5 U.S. gal. on 7th June prevented all but one larva from reaching the backs, but a similar treatment with a 0·25 per cent. spray only reduced the average number of encysted larvae per animal to 5·3, as compared with 11·4 in the untreated animals, a difference that was not significant. At Spur, 90–96 per cent. control of larvae followed one application of a 0·5 per cent. wettable-powder spray at 1 U.S. gal. per head on 17th July. No special steps were taken in any of the experiments to drive the spray through the hair, which was short, or to prevent run-off.

Gersdorff (W. A.) & Piquett (P. G.). **Toxicity of some alkylbenzyl esters of chrysanthemumic acid and two related esters in comparison with allethrin and pyrethrins as house fly sprays.**—*J. econ. Ent.* **52** no. 3 pp. 521–524, 9 refs. Menasha, Wis., 1959.

The following is based on the authors' summary. The results are given of tests made by the Campbell turntable method [*R.A.E.*, B **26** 246] with 12 related synthetic compounds, most of them mono- and di-alkylbenzyl esters of *dl-cis-trans*-chrysanthemic acid, in comparison with allethrin and pyrethrins, in kerosene as space sprays against *Musca domestica* L. The most toxic were the p-ethylbenzyl and 2,4-dimethylbenzyl chrysanthemates. They were, respectively, about 21 and 17 per cent. as toxic as allethrin, and 52 and 54 per cent. as toxic as pyrethrins at the 50 per cent. mortality level; at the 95 per cent. mortality level, these esters were 31 and 20 per cent., respectively, as toxic as allethrin and 88 and 91 per cent. as toxic as pyrethrins. The 3,4-dimethylbenzyl ester was about two-thirds as toxic as its 2,4-isomer. Saturation of the double bond in the acid component of this 2,4-isomer produced a compound one-third as toxic as the unsaturated compound. The knockdown values of the compounds, although excellent at highly toxic concentrations, were much inferior to those of allethrin or pyrethrins at comparable concentrations [*cf.* **48** 54].

Jones (C. M.). **Cattle grub control with ronnel.**—*J. econ. Ent.* **52** no. 3 pp. 524–525, 5 refs. Menasha, Wis., 1959.

Tests were carried out in Nebraska in 1956–57 with ronnel (O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate) administered orally to calves and yearling cattle as a 10 per cent. suspension in a drench for the control of *Hypoderma lineatum* (Vill.) and *H. bovis* (Deg.). Three groups of animals were treated at the rate of 100 mg. per kg. body weight 6–10 weeks before larvae began appearing in the backs. About 75–94 per cent. control was effected. The larvae were most abundant in February, March and April, decreasing progressively during this period. About 60 per cent. of larvae that encysted in February and 45 per cent. of those that encysted in March were *H. lineatum*. Calves had about twice as many larvae as yearlings.

LaBrecque (G. C.), Bowman (M. C.), Acree jr. (F.) & Smith (C. N.). **Adsorption of DDT and its absorption and conversion to DDE by house flies exposed to residues.**—*J. econ. Ent.* **52** no. 3 pp. 528–529, 8 refs. Menasha, Wis., 1959.

When contact insecticides are tested by continuous exposure, differences in knockdown time are presumed to be due to differences in the amount of insecticide acquired, not in the time taken by the insect to react. It has also been assumed that the amount of insecticide acquired could be varied either by changing the amount of insecticide per unit of surface or the period of exposure. In studies with house-flies (*Musca domestica* L.), continuous exposure to deposits of several insecticides other than DDT provided satisfactory measurements of resistance, but the results for DDT with flies from the LDD colony [*R.A.E.*, B **48** 122] followed a different pattern from those with flies of two other colonies, one resistant and the other normal. A series of tests was therefore undertaken to determine whether the total amount of DDT acquired by flies from a treated glass surface was proportional to duration of exposure and whether flies of different strains acquired different amounts during the same exposure period. Since

the acquired (adsorbed) dose is progressively absorbed, it was necessary to recover the DDT present internally as well as externally, and, since it is detoxified by resistant flies, to analyse for DDE as well as DDT.

The flies used came from four colonies, the Orlando no. 1 colony (completely resistant to DDT), the LDD colony (moderately resistant to γ BHC, DDT and dieldrin), a normal colony (never exposed to DDT and highly susceptible to all insecticides [*loc. cit.*]) and the M colony (derived from the normal colony by selection solely with malathion for more than 30 generations, and moderately resistant to malathion and DDT). They were exposed, for periods varying between 10 and 1,080 minutes, in glass jars, the inner surfaces of which had been lightly coated with deposits of 2 or 3·5 mg. p,p′DDT per sq. yd. These deposits allowed an exposure of at least 30 minutes without high or complete knockdown resulting. The jars were inverted over untreated cards so that the flies knocked down during exposure did not acquire more insecticide before they were removed at the end of the exposure period; the flies were then assayed for DDT and DDE. The flies that remained active at the end of the exposure period were anaesthetised, the jars being still inverted, and allowed to fall on untreated cards for removal and similar assay.

Uptake and absorption of DDT increased with increasing exposure in the normal colony and in the highly resistant Orlando colony, but with the LDD colony there was little correlation between uptake and period of exposure, and absorption was influenced by the weight of the deposit much more than by the exposure period. The amount of DDT picked up generally varied with strain, being lowest in the Orlando and highest in the normal colony. However, flies from the Orlando colony absorbed a slightly higher proportion of the adsorbed dose. These flies remained almost stationary on the treated surfaces, whereas normal flies were very active. This probably accounts for at least a part of the difference in the amount picked up. Conversion of internal DDT to DDE generally increased with time of exposure, and the ratio of conversion in different strains generally increased with the degree of resistance [*cf.* **39** 154; **42** 133]. Flies of the normal colony that were knocked down during the exposure period showed more internal DDT and, when exposure was for 30 minutes, more external DDT, than those that were not, and DDE was present in the flies when the period of exposure was so increased that all were knocked down. LDD flies that were knocked down also showed more absorbed DDT than those that were not, but less DDE and less external DDT. In this strain, the proportion of DDT converted to DDE was much higher with long exposures to low deposits than with shorter exposures to higher deposits. No flies of the Orlando colony were knocked down during exposure. Usually, there was more DDE than unconverted absorbed DDT in these flies, but the amount of unconverted DDT remaining after a long exposure was more than enough to cause knockdown and mortality in normal flies. Flies from the M colony converted DDT to DDE as rapidly as flies from the LDD colony in short exposures.

Steve (P. C.). **Parasites and predators of** *Fannia canicularis* **(L.) and** *Fannia scalaris* **(F.).**—*J. econ. Ent.* **52** no. 3 pp. 530–531, 7 refs. Menasha, Wis., 1959.

Natural enemies of *Fannia canicularis* (L.) observed in Massachusetts in 1957–58 included the Pteromalid, *Pachycrepoideus vindemmiae* (Rond.) (*dubias* Ashm.), which was first noted, in laboratory cultures, in November and was parasitising about 70 per cent. of the pupae in a culture of some 600 by the following March. The same species also parasitised *F. scalaris*

(F.). It is not known to have been recorded previously from either of these hosts. *F. canicularis* was also attacked, both in the field and in the laboratory, in autumn by the fungus, *Entomophthora* (*Empusa*) *muscae*. Nymphs and adults of the Gamasid mite, *Macrocheles muscaedomesticae* (Scop.) [*cf. R.A.E.*, B **36** 24], which has not been recorded before as preying on any species of *Fannia*, were found in the breeding medium in cultures of *F. canicularis*. The nymphs readily attacked eggs and first-instar larvae, and adults were often found attached to membranous areas of the flies.

Sternburg (J.) & Corrigan (J.). **Rapid collection of insect blood.**—*J. econ. Ent.* **52** no. 3 pp. 538–539, 1 ref. Menasha, Wis., 1959.

A method was developed during an investigation of biochemical changes in the haemolymph of insects poisoned with DDT, by which comparatively large quantities of the haemolymph of *Periplaneta americana* (L.) were collected by centrifuging. After the body openings had been sealed and the legs and antennae severed, 8–10 cockroaches were put head-downwards on a perforated disk fixed about 40 mm. below the top of each centrifuge tube, the tubes were spun for 5–10 minutes, during which the haemolymph was thrown down through the disk as a clear serum with the cells massed in a layer on the bottom of the tube, and the serum was then decanted or remixed with the cells by gentle swirling.

Roth (A. R.) & Bigley (W. S.). **Sheep ked control with organic phosphorus compounds.**—*J. econ. Ent.* **52** no. 3 pp. 539–540, 1 ref. Menasha, Wis., 1959.

Tests of organophosphorus compounds for the control of *Melophagus ovinus* (L.) were carried out in western Oregon in January–May 1957 and April–June 1958. The insecticides were applied in sprays at 2 U.S. quarts per ewe and 1 U.S. quart per lamb in 1957 and at 2 U.S. quarts per ewe or lamb in 1958. Results were observed after 2–8 weeks. In 1957, Korlan (O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate) gave complete control at concentrations of 0·1–1 per cent. and was equally effective whether used in a suspension or in an emulsion. Malathion at the same rates in an emulsion was almost as effective and was very slightly better than Co-Ral (O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl phosphorothioate) at 0·25–0·75 per cent. in a suspension. Of seven organophosphorus compounds tested at 0·1 per cent. in 1958, Korlan in a suspension or emulsion, Hercules AC-528 (2,3 p-dioxane S,S-bis(O,O-diethyl phosphorodithioate)) in an emulsion and Co-Ral and Dowco 109 (O-methyl O-(4-tert.-butyl-2-chlorophenyl) methylphosphoramidothioate) in suspensions gave complete control. Dicapthon in an emulsion gave 96 per cent. control or over, but stained the wool yellow. Malathion in an emulsion also gave good results, but trichlorphon (Dipterex) in aqueous solution was less effective, giving only 83–85 per cent. control, and was the only phosphorus compound that was inferior to DDT suspension, which was included for comparison.

Rodriguez jr. (J. L.) & Riehl (L. A.). **Results with cockerels for house fly control in poultry droppings.**—*J. econ. Ent.* **52** no. 3 pp. 542–543. Menasha, Wis., 1959.

The possibility of controlling house-flies (*Musca domestica* L.) breeding in the droppings of hens kept in wire cages off the ground by allowing young cockerels access to the droppings was investigated in a small

experimental flock in California. The cockerel chicks were introduced at the rate of one to every ten caged hens and the droppings were artificially infested with house-fly eggs 2–3 times a week. In 11 examinations of samples of wet manure, taken over a period of 26 weeks, house-fly larvae were found on only four occasions, usually only in small numbers, 3–6 in. deep in very wet, impacted manure. No pupae were found, suggesting that the larvae that the chicks had not destroyed were caught when seeking a dry site for pupation. In a part of the building to which the chicks did not have access, means of 25–365 larvae and 26–700 pupae per sample were found at ten examinations 4–26 weeks after the start of the experiment.

Zwick (R. W.). **German cockroach resistance tests in the Panama Canal Zone.**—*J. econ. Ent.* **52** no. 3 pp. 544–545, 3 refs. Menasha, Wis., 1959.

Kitchens and mess halls at army posts in the Panama Canal Zone have been fairly regularly treated since 1950 with chlordane dusts or sprays for the control of *Blattella germanica* (L.), but it has not been possible since the latter part of 1956 to maintain effective control with treatment at the customary interval of 60 days. To investigate suspected resistance, laboratory strains were established from two batches of 75–100 adults collected in February 1958 in Corozal and Curundu; adult males were tested in May and June for susceptibility to deposits of chlordane and malathion at 10 mg. per sq. ft. and of γ BHC (lindane) at 5 mg. per sq. ft., and the results compared with those recorded for normal strains in the United States. The resistance shown by the Curundu strain to chlordane and γ BHC was considerable, but the Corozal strain showed no marked resistance to either, and both strains were normally susceptible to malathion.

Krishna Rao (N. S.) & Mohiyudeen (Syed). *Tabanus* **flies as transmitters of anthrax—a field experience.**—*Indian vet. J.* **35** no. 7 pp. 348–353, 7 refs. Madras, 1958.

A severe epidemic of anthrax occurred in cattle and buffaloes in the Supa Mahal area of North Kanara District, Mysore State, in April–June 1957. Tabanid flies (including *Tabanus indianus* Ric., *T. bicinctus* Ric. and *Haematopota* (*Chrysozona*) *montana* Ric.) were abundant and very troublesome at the time. As 90 per cent. of the affected animals had the disease in the cutaneous form (which indicates infection by inoculation), as the lesions were on the parts of the body favoured by the flies, as incidence was related to Tabanid density both in place and time and as capsulated anthrax bacilli were found in three out of four flies that were taken 16 hours earlier engorging on a cutaneous swelling, it was concluded that Tabanids were transmitting the disease [*cf. R.A.E.*, B **29** 122]. Smears taken from three out of six cases of malignant pustule in man associated with deaths of animals from anthrax were positive for organisms morphologically identical with anthrax bacilli, and three of the six had a history of Tabanid bite at the site of the pustule.

Sen (P.) & Das Gupta (S. K.). **Species complex in** *Culicoides* **(Diptera: Ceratopogonidae).**—*Bull. Calcutta Sch. trop. Med.* **6** no. 4 p. 163, 7 refs. Calcutta, 1958.

Attention is drawn to the need for changes in the nomenclature of four Indian Ceratopogonids. The new name *Culicoides kamrupi* is proposed for

C. albipennis Smith & Swaminath [*R.A.E.*, B **20** 255], which is preoccupied [by *C. albipennis* Kieffer].

Sen (P.). **Insecticide resistance in the bedbug, *Cimex hemipterus* (Fabr.), of Calcutta.**—*Bull. Calcutta Sch. trop. Med.* **6** no. 4 pp. 163–164, 4 refs. Calcutta, 1958.

Resistance to DDT in *Cimex hemipterus* (F.) in India was first reported from parts of Bombay State in which deposit sprays of this insecticide had been used [*R.A.E.*, B **46** 33], and was reported in 1957 from Calcutta, where no such spraying had been carried out. In subsequent tests by the technique of Busvine & Nash [**41** 157], with bugs from an area in Calcutta in which no intensive campaign with chlorinated hydrocarbons or other insecticides had been carried out, exposure for one hour to 2 and 4 per cent. DDT, 0·3 per cent. BHC and 0·3, 0·5 and 1 per cent. dieldrin caused 26, 24, 32, 40, 57 and 86 per cent. mortality, respectively. Similar exposure to 0·125, 0·25 and 0·5 per cent. diazinon and 0·25, 0·5, 1 and 2 per cent. malathion caused, respectively, 16, 20, 72, 43, 83, 87 and 100 per cent. mortality. It is concluded that *C. hemipterus* in Calcutta possesses considerable natural resistance to insecticides.

Papers noticed by Title only.

Hardy (D. E.). **Insects of Hawaii. A manual of the insects of the Hawaiian Islands, including an enumeration of the species and notes on their origin, distribution, hosts, parasites, etc. Volume 10. Diptera: Nematocera—Brachycera.**—ix [+ 1] + 368 pp., 120 figs., 15¼ pp. refs. Honolulu, Univ. Hawaii Press, 1960. Price $7.00. [*Cf. R.A.E.*, A **37** 361.]

Bel'govskiĭ (M. L.). **Inheritance of resistance to insecticides** [largely DDT and BHC] **in insects** [a review of the literature]. [*In Russian.*]—*Zool. Zh.* **37** pt. 7 pp. 1024–1038, 56 refs. Moscow, 1958. (With a summary in English.)

Anderson (C. A.), Adams (J. M.) & MacDougall (D.). **Photofluorometric method for determination of Co-Ral** [Bayer 21/199 (O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl phosphorothioate)] **residues in animal tissues.**—*J. agric. Fd Chem.* **7** no. 4 pp. 256–259, 2 graphs, 9 refs. Easton, Pa., 1959.

Bowman (M. C.), Beroza (M.) & Acree jr. (F.). **Colorimetric determination of 2-ethyl-1,3-hexanediol.**—*J. agric. Fd Chem.* **7** no. 4 pp. 259–261, 4 graphs, 3 refs. Easton, Pa., 1959.

KHUDADOV (G. D.). **The method of labelling insects by introducing radioactive isotopes into their food.** [*In Russian.*]—*Byull. mosk. Obshch. Isp. Prir.* Otd. biol. **64** pt. 3 pp. 35–45, 3 graphs, 19 refs. Moscow, 1959. (With a summary in English.)

The literature on the use of radioisotopes for labelling insects is reviewed, and an account is given of investigations in the Soviet Union to find the most suitable for this purpose and to develop a method for their administration to insects in their food. Radioisotopes with different half-lives and giving off β-particles or γ-radiation or both were used in the form of readily water-soluble compounds, and the insect first tested was *Musca domestica* L.

Radioactive phosphorus (^{32}P), which has a half-life of 14·3 days and was used as a standard, proved to be the best. The flies to be labelled were maintained in lots of 250–400 in cloth cages measuring 8 × 8 × 8 in., and food was provided in petri dishes. To determine the period for which radioactive material should be available so as to ensure that all the flies are labelled, exposures of 1, 2, 3 and 24 hours to food containing ^{32}P were tested, the specific activity being 1 μc. per ml. food. The results showed that these exposures resulted in 60, 82, 86 and 100 per cent. of the flies becoming satisfactorily labelled, and that the degree of radioactivity of the labelled insects increased with the exposure. A feeding period of 24 hours was adopted, and the composition of the food was standardised at 3 parts milk and 1 part 10 per cent. sugar solution, which proved suitable for all radioisotopes except iron, with which sugar solution was used alone.

The relation between the concentration of radioisotope in the food and the radioactivity of the flies was investigated by using eight concentrations of ^{32}P affording 0·25–5 μc. per ml. The relation was a direct one, doubling the concentration about doubling the radioactivity of the labelled flies. The radioactivity of the females was about twice that of the males, which is explained by the fact that they weigh about twice as much. The radioactivity of flies that had received 1 μc. ^{32}P per ml. food, as above, was halved after two days but was still 4 per cent. of its original value after 19 days, the decrease being 1·5 times as rapid for males as for females.

The suitability of other radioisotopes was then investigated, and radioactive calcium (^{45}Ca), iodine (^{131}I), iron (^{59}Fe) and zinc (^{65}Zn), which have half-lives of 152, 8·14, 45·1 and 250 days, respectively, were tested. When used in the standard feeding technique, the first three, emitting β-particles, did not give clearly defined results. Calcium and iodine proved more satisfactory at 50 μc. per ml., but iron could not be used at more than 20 μc. without being toxic to the flies. The fall in radioactivity of the flies, which depends on the rate of elimination of the isotopes and their intrinsic rates of decay, was greatest for calcium and least for iron. The amount of radioactivity present after five days for calcium was only 3 per cent. of the original amount, although the half-life of this isotope is longer than that of the others, whereas the corresponding percentage for iodine after 15 days was 47.

Attention was then paid to the differing impulse counts obtained after the flies had been fed on radioactive calcium, iron, iodine and phosphorus. These differ in the energy of their β-particles, and the energy is responsible for their penetration of matter. When insects are fed on radioactive food, external contamination is negligible, so that, for the β-particles to reach the counter, they have to pass through a layer of insect tissues, which is comparable to passing through water, and then through the layer of air separating the counter from the insect, but absorption by the air layer, which is usually not a thick one, can be neglected; furthermore, the counter does not register all β-particles, but only those with a defined minimum and maximum of energy. Investigation showed that absorption by the

tissues varied inversely with the energy of the particles. It is concluded that isotopes emitting β-particles of high energy are the most suitable.

Attempts to label the flies with radioactive zinc, which emits the more penetrating γ-radiation, were not successful, largely owing to the failure of the counters to register more than a low proportion of the radiation. A concentration of more than 24 μc. per ml. in the food proved toxic to the flies, the counts were low, and the labelled flies soon lost their radioactivity.

Radioactive yttrium (^{91}Y), strontium (^{89}Sr) and barium (^{140}Ba), which have powerful β-radiation and half-lives of 61, 53 and 12·8 days, respectively, were then tested. The radioactivity of the labelled flies fell rapidly for three days, but then much more slowly, and the counts obtained from flies fed on food containing 3 μc. of these isotopes per ml. were adequate for practical purposes. The only radioisotope that could not be used because of toxicity to the flies was cadmium (^{115}Cd). Another advantage of the isotopes that emit high energy β-particles was that flies labelled with them retained their radioactivity throughout the experiment (10–20 days). Some of those labelled with radioactive calcium gave no counts after three days, and about 50 per cent. of those labelled with radioactive iron gave none after nine days; the same applied to iodine (at a rate of 20 μc. per ml.) and to zinc, 24 per cent. of the flies labelled with which showed no radioactivity within a day.

Further tests with radioactive phosphorus were carried out with *Calliphora vicina* R.-D. (*erythrocephala* (Mg.)), *Culex pipiens* L. and *Blattella germanica* (L.), concentrations of 1 μc. per ml. being added to their food (milk and 10 per cent. sugar solution (3 : 1) for *Calliphora*, wadding moistened with water for *Culex*, and rye biscuits for *Blattella*). Labelling was satisfactory after feeding for 24 hours by the first two and for 48 hours by the cockroach, all individuals being labelled and radioactivity falling at the same rate as for *M. domestica*.

Digby (P. S. B.). **Flight activity in the blowfly** *Calliphora erythrocephala*, **in relation to light and radiant heat, with special reference to adaptation.** —*J. exp. Biol.* **35** no. 1 pp. 1–19, 12 figs., 23 refs. London, 1958.

The following is virtually the author's summary. The spontaneous flight activity of a population of *Calliphora vicina* R.-D. (*erythrocephala* (Mg.)) has been studied in relation to light and radiant heat in a small wind tunnel. Flight activity occurs at a low level in the dark under these conditions, and is practically independent of light up to 10 lux. Activity increases sharply with light between 10 and 2,600 lux, before heating effects become important. Population activity shows adaptation to light intensity, and a method of analysis is described. The rate of increase of activity following an increase of light is much slower than is the reverse change; the state of low activity at low light intensities tends to persist. Complete adaptation would take at least a number of hours. Heating, which accompanies strong light intensities, causes initially a momentary decrease in activity, usually followed by an increase. Similar reactions occur when the heat is applied in several different ways.

Kaplanis (J. N.), Hopkins (D. E.) & Treiber (G. H.). **Dermal and oral treatments of cattle with phosphorus-32-labeled Co-Ral.**—*J. agric. Fd Chem.* **7** no. 7 pp. 483–486, 7 refs. Easton, Pa., 1959.

The following is based on the authors' summary. In experiments in Texas in which Co-Ral (O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl

phosphorothioate) was applied to cattle, only small amounts of ^{32}P were absorbed through the skin and eliminated in the urine following dermal application of the radioactive compound. Considerable amounts of the unchanged toxicant were found on the hair several weeks after treatment. The compound was ineffective as a systemic insecticide against stable flies [*Stomoxys calcitrans* (L.)] and against screw-worm larvae [*Callitroga hominivorax* (Coq.)] feeding in wounds, but highly effective against these insects by contact. When it was administered orally at 10 and 20 mg. per kg. body weight, some 38 per cent. of the dose was excreted in the urine as polar degradation products and about 35 per cent. in the dung within seven days of treatment.

Terriere (L. C.), Arscott (G. H.) & Kiigemagi (U.). **The endrin content of eggs and body tissue of poultry receiving endrin in their daily diet.** —*J. agric. Fd Chem.* **7** no. 7 pp. 502–504, 14 refs. Easton, Pa., 1959.

The following is virtually the authors' summary. The tissues of chickens and the eggs of pullets that ingested small amounts of endrin daily in their food were examined for endrin residues by a specific spectrophotometric method of analysis. Results were confirmed with a non-specific bioassay method sensitive to 0·02 part endrin per million. At the lowest level of intake, 0·1 p.p.m., endrin could not be detected in the eggs, but it was present in the body fat. Both were contaminated with endrin at higher levels of intake.

Gersdorff (W. A.), Freeman (S. K.) & Piquett (P. G.). **Some barthrin isomers and their toxicity to houseflies in space sprays.**—*J. agric. Fd Chem.* **7** no. 8 pp. 548–550, 2 graphs, 18 refs. Easton, Pa., 1959.

The following is based on the authors' summary. Barthrin (6-chloropiperonyl *dl-cis-trans*-chrysanthemate) is highly toxic to house-flies (*Musca domestica* L.) in sprays applied by the Campbell turntable method [*cf. R.A.E.*, B **48** 96]. In the tests described, the 6-chloropiperonyl esters of *d-trans-*, *dl-trans-*, *dl-cis-* and *dl-cis-trans*-chrysanthemic acid were synthesised and tested on *M. domestica* in the same way. These esters and the *l-trans* ester (by inference) were 62, 38, 29, 32 and 14 per cent. as toxic as allethrin, at the 50 per cent. mortality level, and the ratios were one-third greater at the 95 per cent. level. Year-old sprays of barthrin were just as toxic as sprays from a freshly prepared sample. The knockdown values of barthrin and the three isomers, although excellent at highly toxic concentrations, were much inferior to that of allethrin at comparable concentrations.

Fairchild (H. E.). **"Sesoxane" as a synergist for methoxychlor.**—*Soap & chem. Spec.* **34** no. 1 pp. 82, 84, 151, 4 refs. New York, N.Y., 1958.

The results are given of preliminary laboratory experiments with sesamex (Sesoxane) as a synergist for methoxy-DDT (methoxychlor) in acetone sprays applied to various arthropods including house-flies (*Musca domestica* L.) and nymphs of *Blattella germanica* (L.). Against these two species, the spray was delivered downwards from an aspirator sprayer on to the insects in screen-topped cages or open dishes on a moving conveyor at a rate of about 5 mg. liquid per sq. cm. Methoxy-DDT alone at 0·05 and 0·07 per cent. gave 36·6 and 49·3 per cent. kill, respectively, in 24 hours, of

normal house-flies, and the addition of an equal amount of sesamex, which caused no mortality alone, raised the kills to 90 and 97·3 per cent. In another test, the kill effected by 0·05 per cent. methoxy-DDT alone was raised by the addition of 0·01 or 0·005 per cent. sesamex from 24 to 42 and 50 per cent., respectively. In tests against flies of a resistant strain, the addition of sesamex at ratios of 1 : 1, 1 : 5 and 1 : 10 raised the percentage kill effected by 0·4 and (in brackets) 0·75 per cent. methoxy-DDT from 7 (27) to 32 (60), 21 (59) and 23 (39), respectively. Improvements in knockdown were also pronounced in normal flies but less marked or absent in resistant flies. Against nymphs of *B. germanica*, the 24-hour kill caused by 0·25 per cent. methoxy-DDT was raised from 5 to 46·7, 20 and 13·3 per cent. by the addition of 0·25, 0·05 and 0·025 per cent. sesamex, respectively, that given by 4 per cent. methoxy-DDT from 36·7 to 100 and 98·3 per cent. by the addition of 0·5 and 1 per cent. sesamex and that caused by 2 per cent. methoxy-DDT from 13·3 to 98·3 per cent. by the addition of 1 per cent. sesamex. There was little or no effect on knockdown, and no mortality from sesamex alone, except at 1 per cent., at which it was negligible.

The combination of methoxy-DDT and sesamex would appear to be highly desirable for the control of household insects, as their acute oral LD50's for rats have been reported to be as high as 6 and 2 g. per kg., respectively.

Chang (Shih-chieh). **The races of *Anopheles maculipennis* and their distribution in the north eastern provinces of China.** [*In Chinese.*]—*Acta ent. sin.* **8** no. 3 pp. 266–271, 2 pls., 15 refs. [Peking] 1958. (With a summary in English.)

Investigations in Hailar and Ya-Ke-Shih, in Inner Mongolia, and Ou-Pu, in Heilungkiang Province, in north-eastern China, showed that *Anopheles maculipennis* Mg. is represented there by subsp. *messeae* Flni., which overwintered in unheated cellars and caves in which the temperature was sometimes lower than −15°C. [5°F.].

Walton (G. A.). *Argas persicus* (**Oken 1818**), (**Argasidae Ixodoidea**) **in Tanganyika Territory.**—*E. Afr. med. J.* **35** no. 10 pp. 573–574, 1 ref. Nairobi, 1958.

In February 1957, 73 examples of *Argas persicus* (Oken) were collected at Ngudu in the Kwimba District of the Lake Province of Tanganyika Territory from a newly felled tree of the genus *Ficus* that had for some time been a roosting place of a species of heron. This tick, which attacks various birds and is a pest of domestic poultry, is known to occur in Kenya [*R.A.E.*, B **19** 177] and Uganda, but is believed not to have been previously recorded from Tanganyika. The author found no evidence of infestation in 510 huts examined in the Lake Province [above 3,200 ft.], but in the Teita Hills in Kenya, in August and September 1950, heavy infestations were found in four out of 74 huts below 3,500 ft., though none was found in 333 above that altitude. The four infested huts were situated at about 2,500 ft., where the temperature was high and humidity low. There were ticks in all stages of development in crevices in the rough mud walls, and examination of the blood in the stomachs of five from two of the huts showed that they had fed on fowls. All the fowls in the other two huts had died. The people in both groups of huts stated that the ticks occasionally bit them.

Smith (A.). **Outdoor cattle feeding and resting of** *A. gambiae* **Giles and** *A. pharoensis* **Theo. in the Pare-Taveta area of East Africa.**—*E. Afr. med. J.* **35** no. 10 pp. 559–567, 2 graphs, 3 refs. Nairobi, 1958.

The studies described were made in a region that includes the Pare area of Tanganyika and the Taveta district of Kenya and in parts of which cattle are numerous and are penned overnight in unroofed enclosures [*R.A.E.*, B **47** 110]. Collections, lasting half an hour, of adult Anophelines on the wall of such an enclosure were made at intervals through several nights in April 1955. The density of unfed females of *Anopheles gambiae* Giles increased between 7 p.m. and 1 a.m. and then declined. A corresponding increase in numbers of fed females occurred about four hours later, suggesting a delay of this duration between arrival and feeding, and there appeared to be no appreciable feeding without an initial resting period. There was a peak in numbers of both unfed and fed females of *A. pharoensis* Theo. on the wall at 7 p.m. (about an hour after dusk), after which the density of unfed females decreased sharply and continued to fall until dawn, while that of fed females decreased until 3 a.m. and then increased to a second peak at 5 a.m. This indicates that the resting period before feeding is short and disappears before dawn. In all, twice as many fed as unfed females of this species were caught, and this is interpreted as showing that about half the females of *A. pharoensis* rest on the enclosure wall before feeding. Of 65 females of *A. gambiae* subjected to precipitin tests, two were positive for man, 56 for ox, three for both and three for sheep or goat and one was negative for all these. All of 55 females of *A. pharoensis* were positive for ox. A few females of both species remain for the day in enclosure walls of living vegetation, but all leave those made of dead vegetation or stakes at dawn. Catches made at 5 and 6 a.m. on three nights in May on enclosure walls and in neighbouring earth-covered box traps [**42** 119] showed that most females of both species left the enclosure wall by 6 a.m. (shortly after dawn) and that *A. gambiae* entered box traps but *A. pharoensis* did not.

Day-time spray catches in April from six huts near cattle enclosures included 1,387 females of *A. gambiae* but none of *A. pharoensis*, and 54 per cent. of 221 of the females of *A. gambiae* subjected to precipitin tests had fed on cattle and 37 per cent. on man. Comparative catches in July in huts near and at a distance from cattle enclosures showed *A. gambiae* to be more numerous in the former, again indicating the use of huts as daytime resting places by females of this species that had fed on cattle. The catch of the almost entirely man-biting females of *A. funestus* Giles was not affected by proximity to cattle enclosures. *A. gambiae* was also found by day under eaves and on outside walls of huts near cattle enclosures, and 91 per cent. of the females examined had fed on cattle. Vegetation thus appears to be the day-time resting place of most of the females of *A. pharoensis* and of some of those of *A. gambiae* that have fed at cattle enclosures.

M. T. Gillies has shown that the distribution of the total feeding population of *A. gambiae* between outdoor and indoor resting places can be estimated by analysis of the proportion of fed [*cf.* **42** 119] to gravid females found resting outdoors and indoors. The distribution between indoor and outdoor resting places of the females that have fed on cattle can be determined by weighting the distribution of the total feeding population by the proportion of cattle-fed females amongst those resting outdoors and indoors. This was done for two villages, and the results are given for both and the data and calculations on which they were based for one of them. At Mata, in Kenya, where vast herds of cattle are kept and

overgrazing has reduced vegetation near enclosures and huts, about 90 per cent. of the total feeding population had fed on cattle and about half of the cattle-fed females were estimated to rest outdoors, the remainder entering huts on the first or second night after feeding. In Bumba, in South Pare, on the other hand, where fewer cattle are kept and there is more vegetation near enclosures and huts, there was an indication that 58 per cent. of the total feeding population fed on cattle and that 74 per cent. of the cattle-fed females rested outdoors through the whole gonotrophic cycle.

Smith (A.) & Draper (C. C.). **Malaria in the Taveta area of Kenya and Tanganyika. Part I. Epidemiology.**—*E. Afr. med. J.* **36** no. 2 pp. 99–113, 1 map, 12 refs. Nairobi, 1959.

The observations described were made in 1954 and 1955 in the Taveta area of Kenya and to the west of it in Tanganyika at an average altitude of 2,500 ft. The local vectors of malaria are *Anopheles gambiae* Giles and *A. funestus* Giles, and no other species has been found infected. Their behaviour was much the same as that found in similar observations in South Pare [*R.A.E.*, B **47** 110]. They breed by the banks and in the delta of the river Lumi, in the permanent natural swamps and seepages in the band of forest four miles wide that fringes a section of the river, and in irrigation and drainage canals. *A. gambiae* also breeds in temporary ground pools. Monthly catches of adults were made with the aid of floor sheets and a pyrethrum spray between September 1954 and August 1955 in selected huts. They showed that the density of *A. gambiae* was greatest between March and June, during and soon after the long rains, with a peak in May. Except in the dry areas away from the river and swamps, *A. funestus* was generally more abundant than *A. gambiae* and showed less marked seasonal variation. Two peaks could be distinguished for *A. funestus*, one between March and June and the other between September and November. The first is due to the extension of the natural swamps during the rains, and the second follows their extension by later seepage of water into them from the foot-hills of Kilimanjaro. If an effect of temperature on ovarian development similar to that recorded in South Pare and elsewhere [**42** 113] is assumed, the gonotrophic cycle of *A. gambiae* and *A. funestus* would last about two days for the greater part of the year [*cf.* **47** 111], and this was confirmed for the hotter months by analysis of the ovarian stages of mosquitos caught in spray catches during March 1955.

There was an excess of fed [*cf.* **42** 119] over gravid females of *A. gambiae* in huts in some areas, indicating that about half left the huts before they became gravid, but there was an excess of gravid females at Mata, suggesting that here, where outdoor feeding on cattle is considerable [*cf.* preceding abstract], any egress of females from huts is more than offset by entry of gravid females on the second night after feeding outside. For *A. funestus*, egress of females is less than for *A. gambiae* but again shows some differences from place to place, probably related to the availability of outside resting sites. In a study with experimental huts fitted with exit window traps, 11–12 per cent. of the catch of each species over a period of a year was found in the window traps on the night of feeding. Precipitin tests on more than 3,000 females showed that man and cattle are the sources of 90 per cent. of the blood-meals of both species. In the forest, where man and cattle share the same huts, *A. gambiae* feeds for preference on man, but where cattle are kept in separate enclosures, it readily deviates to them. In the case of *A. funestus* caught in huts,

most have fed on man irrespective of the proximity of cattle. The extent to which *A. gambiae* rests outside huts was studied by the use of earth-covered box shelters, of which there were 20 in the forest and five at Mata. In the forest, where alternative resting places were numerous, the average catch was six and there were more gravid than fed females, whereas the average catch at Mata, where mosquitos were more numerous and outside resting places fewer, was 257 and fed females outnumbered gravid ones; precipitin tests showed that most had probably fed on cattle.

Sporozoite rates in females of *A. gambiae* and (in brackets) *A. funestus* [*cf.* **47** 111], caught over a period of a year, were 0·66 (0·7) in Taveta forest and 0·1 (0·37) outside the forest. The explanations put forward for the lowness of the rates in South Pare (aridity and deviation to cattle) are acceptable for the Taveta area outside the forest, but the climate in the forest is more humid and there are fewer cattle. It is possible, however, that most mosquitos are not confined to the forest but are exposed to conditions outside it for part of their lives. It is calculated from the entomological data that the approximate annual malaria inoculation rates per person in villages in the forest, and (in brackets) outside it, were 3–6 (1) infective bites from *A. gambiae* and 9–21 (1–13) from *A. funestus*. *A. funestus* is the chief vector in all areas. In the forest, it is more plentiful than *A. gambiae* in huts and their sporozoite rates are similar; outside the forest, it may not be more plentiful but its sporozoite rates are nearly four times those of *A. gambiae*. Transmission is heaviest in the forest, and steady hut densities of *A. funestus* ensure that there is little seasonal variation.

Timms (G. L.), Heisch (R. B.) & Harvey (A. E. C.). **Further evidence that *Rhipicephalus simus* Koch is a vector of tick typhus in Kenya.**—*E. Afr. med. J.* **36** no. 2 pp. 114–115, 2 refs. Nairobi, 1959.

Rhipicephalus simus Koch is known to harbour rickettsiae of the type of *Rickettsia conori* that cause a disease indistinguishable from tick typhus when inoculated into man [*R.A.E.*, B **48** 130]. An account is here given of the symptoms of a case of natural infection, which were not typical of tick typhus but occurred after the removal of an example of this tick from the thigh, and of serological tests that showed the infection to have been rickettsial. A guineapig into which a suspension of the tick was injected developed a scrotal reaction and was found to contain rickettsiae of the type of *R. conori*. J. H. S. Gear concluded from complement-fixation tests that antibodies to *R. conori* var. *pijperi* were present in the serum of a second guineapig into which these rickettsiae were injected. Injection of the patient's serum in the acute phase into animals was not possible, but two lots of serum collected subsequently showed antibodies to *R. akari* at 1:10 in complement-fixation tests on one occasion and to *R. akari* at 1:4 and to *R. conori* var. *pijperi* at 1:2 on the other. Gear concluded that this showed that the patient had had tick typhus or rickettsialpox. Sera of several rodents (*Otomys angoniensis*) caught near her house were shown by complement-fixation tests to contain antibodies to *R. conori* var. *pijperi*.

Gillies (M. T.) & Smith (A.). **The effect of a residual house-spraying campaign in East Africa on species balance in the *Anopheles funestus* group. The replacement of *A. funestus* Giles by *A. rivulorum* Leeson.**—*Bull. ent. Res.* **51** pt. 2 pp. 243–252, 1 graph, 4 refs. London, 1960.

The Taveta-Pare Malaria Control Scheme was intended to test the effects of house spraying with dieldrin on the transmission of malaria in an inland

region of Kenya and Tanganyika. Detailed accounts of preliminary observations have already been noticed [*R.A.E.*, B **47** 110; **48** 178]. The subject of this paper is the effect of the spraying on the Anopheline population in the South Pare district of Tanganyika; this was studied mainly from routine catches of mosquitos resting in artificial outdoor box shelters [**42** 119] made at Kihurio throughout the experimental period beginning in May 1954, 18 months before the inception of spraying. During the pre-treatment period, catches consisted chiefly of the principal vectors, *Anopheles gambiae* Giles and *A. funestus* Giles, which was seasonally abundant, with small numbers of *A. rivulorum* Leeson, an exophilous member of the *funestus* group. In the three years following spraying, *A. funestus* disappeared almost completely from the catches, the last specimen to be identified with certainty as belonging to this species being caught in January 1956. At the same time, peak catches of *A. rivulorum*, which was most plentiful from April to June or July, increased from 11·1 and 4·6 per 20 box-days in 1954 and 1955 to 32–110 in 1956–58. The period of peak incidence corresponds with that previously noted for *A. funestus* in the Pare area [**47** 111]. Catches on man at Gonja confirmed the change. Similarly, catches in huts in swamp villages consisted almost entirely of *A. gambiae* and *A. funestus* before spraying, but *A. funestus* was replaced by very small numbers of *A. rivulorum* soon after spraying was begun. It is concluded that the increase in numbers of *A. rivulorum* was associated with the disappearance of *A. funestus* from breeding sites formerly occupied by both species. There had been no major change in breeding areas that could be responsible. Precipitin tests indicated that *A. rivulorum* feeds mainly on cattle and only to a very small extent on man, preferring the blood of domestic animals whenever it is available, and it is not believed to have played any part in malaria transmission.

Kirkby (W. W.) & Blasdale (P.). **The eradication of *Glossina morsitans submorsitans* Newst. and *Glossina tachinoides* Westw. in part of a river flood plain in Northern Nigeria by chemical means. Part II.**—*Bull. ent. Res.* **51** pt. 2 pp. 253–264, 4 figs., 5 refs. London, 1960.

Davies (H.) & Blasdale (P.). **Part III.**—*T. c.* pp. 265–270, 2 maps, 3 refs.

It was concluded from an experiment in 1956 in a small isolated area of bush in the Sudan savannah zone in Northern Nigeria that *Glossina morsitans* Westw., which is represented there by subsp. *submorsitans* Newst., could be eradicated by a single application of a spray containing 5 per cent. DDT in wettable-powder suspension to the tree trunks in the thickets to which the fly is restricted in the dry season [*R.A.E.*, B **46** 71]. In the first of the present papers, an account is given of the development of this technique and its application on a large operational scale in 1957 to an elongated riverside area, 80 sq. miles in extent, to the north of the original one and infested with both *G. morsitans* and *G. tachinoides* Westw. The experimental area was isolated by an artificial barrier of ruthless clearing one mile wide at the north-eastern (downstream) end. At the south-western end, it was separated from the previously treated area by a natural barrier five miles wide. This isolated it as far as *G. morsitans* was concerned. The physical features of the area, its vegetation, climate and fauna are described. *G. morsitans* was the commoner of the two species. It was fairly generally distributed through the area during the rains and penetrated for some distance into the open orchard bush of the upland to the west, but as conditions became more severe, it retreated to the denser patches of vegetation at the edges of the upland, vegetation on termite mounds and

above all the riverside thickets. Concentration was most intense in March and April, and dispersal began again at the end of May. Breeding sites were largely concentrated in the thickets at all times. *G. tachinoides* had a more restricted habitat, being more or less dependent on water and confined to the riverine thickets all through the year.

Cutting roads and paths as a preliminary to spraying began in December, and the area remained accessible for motor transport until May, but the concentration of fly favourable for spraying occurred only between February and April, and this period proved inadequate to treat the whole area planned. Starting at the south-western end, workers moved downstream, spraying with 5 per cent. DDT from knapsack sprayers. Except in the case of *Mimosa*, the spray was applied only to tree trunks of more than 6 in. in diameter and up to a height of 5 ft. Tree trunks exposed to the sun or wind were ignored, and creepers and foliage were not intentionally treated. Spray was, however, applied to holes and crevices, overhanging limbs, fallen trees and overhanging roots on river banks, and large animal burrows were well sprayed inside. Catches were reduced to 0 in 4–7 weeks after spraying, and many of the flies caught before reduction was complete were teneral. Although time did not allow of treatment of the whole area as far as the barrier, re-invasion of the treated from the untreated part was on a small scale. As the cost of clearing the barrier was large compared with that of spraying, and as 48 sq. miles were still free of fly at the beginning of the following dry season, it may be more economical to tolerate re-invasion than to prevent it. Tests of the persistence of the DDT on bark are briefly described in an appendix, and it is concluded that, although the limit of useful persistence is not yet known, it is at least 52 days.

In the second paper, an account is given of the extension, during a third dry season, of the work described in the first. The belt is about 120 miles long and in places nearly ten miles wide, and 69 sq. miles of it were sprayed with DDT between the end of January and the end of April 1958. At this time, the scattered flies left in the part treated in 1957 had died out, and re-invasion from the part that had been left untreated extended for only about two miles southwards. Spraying in 1958 was started about one mile to the south of this. A spray of 5 per cent. DDT in wettable-powder suspension was used at first, but a 3·75 per cent. suspension was substituted half-way through the season and found to be adequate. Spraying against *G. morsitans* was confined, more strictly than before, to the trunks of trees exceeding about 8 in. in diameter and well shaded by their canopies or adjacent thicket, and no spraying was done above 5 ft. However, in the case of riverine vegetation, in which the low-flying *G. tachinoides* was also prevalent, tree trunks of smaller diameter, and sometimes the sides of paths cut between thick shrubs, were also sprayed. At the end of 1959, surveys of the area treated in 1958 failed to reveal the presence of a single fly, and the northward extension of spraying in the following season prevented re-invasion from that direction. The area sprayed in 1956 remained free of *G. morsitans*, but *G. tachinoides* was found there after two years owing to re-invasion from the south. The area was later isolated in this direction by ruthless clearing, and riverine vegetation was resprayed. The area sprayed in 1957 remained free of both species. The cost of insecticide and labour in 1958 was about £86 per sq. mile, but since *G. morsitans* ranges far beyond the limits of its dry-season foci in the rains, reclamation costs per sq. mile of grazing land made safe are very much lower. As eradication can be achieved with a single application of a 3·75 per cent. spray applied on a highly selective basis, and as the problem of re-infestation can be solved by spraying without the use

of barriers, where the fly-belt is long and narrow, it is hoped that the Sudan savannah vegetational zone may ultimately be freed of tsetse by the technique described.

WARD (J.), GILLHAM (E. M.) & POTTER (C.). **A thermal preference method of bioassay of the toxicity of insecticidal films to house-flies.**—*Bull. ent. Res.* **51** pt. 2 pp. 379–387, 4 figs., 7 refs. London, 1960.

The following is based partly on the authors' summary. Methods that have been used to confine insects to the test surface during exposure to insecticidal deposits are briefly reviewed and their limitations discussed, and some unsuccessful preliminary experiments on alternative methods are mentioned. A temperature-preference method of inducing house-flies (*Musca domestica* L.) to remain on a treated surface is described, and the apparatus used is illustrated. The test surface forms the floor of a chamber and is maintained at a higher temperature (30°C. [86°F.]), which is preferred, than the walls and lid. The flies are introduced by means of a plunger device.

In tests of the performance of the apparatus, plain glass plates, plates coated with wax, or cabbage leaves were used as the test surface; they bore deposits from a crystalline suspension of DDT needles 60μ long, or from an emulsified solution of DDT in xylene, or of a solution of DDT in liquid paraffin. A deposit of the last was produced by applying a solution of DDT in a mixture of 78 parts by volume xylene, 20 parts ethylene glycol monoethyl ether and two parts liquid paraffin, which spreads on glass and evaporates to leave an even film of DDT in liquid paraffin. Concentrations of DDT up to 0·15 per cent. w/v can be dissolved in the solvent without crystallisation of the ultimate film. The suspensions were satisfactory on both leaves and plates; the emulsified solutions gave deposits that crystallised irregularly and gave very variable results on the plates, but were more toxic and gave more uniform results on the leaves; the deposits of DDT in liquid paraffin were of low toxicity on the leaves, perhaps because the solvent soaked into the latter, and were therefore not used on them.

The variance in mortality among groups of house-flies given the same exposure was determined in three experiments. In the first, plates sprayed with the suspension were used immediately after spraying, and the variance was high. In the second, the same set of plates was used 24 hours later, and the results were not significantly heterogeneous. In the third, plates bearing deposits of DDT in liquid paraffin were used, and the results were just significantly heterogeneous. The heterogeneity is thought to have been due to variations in the activity of the flies while on the test surface, but it was too small to affect probit lines calculated from the results. Nine successive experiments, in which the LD50 for DDT in liquid paraffin on glass plates was determined, gave a range of results from 0·69 to 1·45 μg. DDT per sq. cm. and probit-line slopes in the range 2·8–6·2. One of the experiments gave significantly heterogeneous results.

In seven experiments to determine the toxicity of DDT applied in emulsified solution to cabbage leaves, the probit lines were too steep for calculation by the normal method, but all the points fell between parallel lines intersecting the 50 per cent. mortality abscissa at deposit levels of 1·4 and 2·7 μg. per sq. cm., a variation in resistance no greater than is usual between cultures of test insects.

The behaviour of insects of some other species in the test chamber was observed. The apparatus would probably be suitable for use with *Blattella*

germanica (L.), but some species failed to respond to the temperature gradient and others were too small for the apparatus as described.

Davis (A. N.). **Colonization of** *Aedes taeniorhynchus*.—*Mosq. News* **18** no. 1 pp. 4–5, 1 ref. Albany, N. Y., 1958.

A laboratory colony of *Aëdes taeniorhynchus* (Wied.) was established at Orlando, Florida, in 1957 and was continuing without sign of deterioration in size, vigour or fecundity in the F_5 generation. The adults were kept at 84°F. and 70 per cent. relative humidity, in natural daylight, in a cage 30 in. square by 25 in. high with sides of 18-mesh screen and top and bottom of plywood. Undiluted honey and fresh water were constantly available, a shaved rabbit was provided for 2–3 hours daily, and damp *Sphagnum* moss in a white pan was introduced as an oviposition medium three days after the first blood-meal and left for 25 days. Water was added as needed to keep the moss damp. To stimulate hatching, the moss was transferred to a clean pan and flooded. Hatching began within a few minutes and was apparently complete within a few hours. After 24 hours, the larvae were distributed in fresh pans containing infusion water, obtained by soaking a salt-marsh sod in tap water for 24 hours. Powdered dog food was added twice daily. Pupation occurred in 6–12 days. About 6,000 pupae were used to start the colony, which has been maintained at a level of 10,000–20,000 adults, 50–75 per cent. of each generation having been used for testing insecticides.

Beck (E. C.). **A population study of the** *Culicoides* **of Florida (Diptera: Heleidae).**—*Mosq. News* **18** no. 1 pp. 6–11, 10 refs. Albany, N. Y., 1958.

The following is based on the author's summary. Six light-traps were operated at regular intervals in different areas of Florida in 1955 and 1956 to provide data on the relative and seasonal abundance of the various species of *Culicoides*. Of the 25 species taken, 14 were caught in large enough numbers to indicate that they contribute to annoyance. Near the coast, *C. furens* (Poey), *C. canithorax* Hoffman, *C. melleus* (Coq.) and, possibly in some regions, *C. loughnani* Edw. are the prevalent species. Inland, *C. inamollae* Fox & Hoffman in the south and *C. crepuscularis* Mall. and *C. haematopotus* Mall. in the north appear to be the most abundant.

Blackmore (J. S.) & Dow (R. P.). **Differential feeding of** *Culex tarsalis* **on nestling and adult birds.**—*Mosq. News* **18** no. 1 pp. 15–17, 1 fig., 1 ref. Albany, N. Y., 1958.

An account is given of tests made in Colorado and California to determine whether females of *Culex tarsalis* Coq. that have been attracted to birds are more likely to feed on nestlings or on adults. It was assumed that the stimulus that caused the mosquitos to approach the birds was generally the sum of the attractiveness of the young and the parents. The results indicated that mosquitos feed much more readily on nestlings than on adults, probably because they are nearly free of feathers and move about less. Nestlings may therefore be assumed to be more important than adult birds as reservoirs of the viruses of western equine and St. Louis encephalitis [*R.A.E.*, B **47** 7], of which *C. tarsalis* is an important vector, and birds

that nest during the encephalitis season may be more important as reservoirs than those that do not. Other factors, however, may modify or even nullify the effects of differential feeding on adults and young.

Lewallen (L. L.) & Brydon (H. W.). **Field tests with organo-phosphate granular insecticides against mosquito larvae in Lake County, California.**—*Mosq. News* **18** no. 1 pp. 21–22, 3 refs. Albany, N. Y., 1958.

In field trials with insecticides on granules of calcined montmorillonite (bentonite) [*cf. R.A.E.*, B **47** 201] in California in July 1957, the lowest rates of application that gave complete 24-hr. mortality of larvae of *Culex tarsalis* Coq. and *Anopheles freeborni* Aitken among low-growing vegetation at a lake margin were 0·5 and 1 lb. per acre, respectively, for trichlorphon (Dylox) and 0·25 and 0·5 lb. for Guthion. Guthion at 0·1 lb. per acre caused considerable mortality among *Gambusia*, but trichlorphon at 1 lb. caused none.

Edmunds (L. R.). **Field observations on the habitats and seasonal abundance of mosquito larvae in Scotts Bluff County, Nebraska (Diptera, Culicidae).**—*Mosq. News* **18** no. 1 pp. 23–26, 5 refs. Albany, N. Y., 1958.

Mosquito breeding in irrigation areas was studied in western Nebraska in 1953, and a mixture of species was found in almost every habitat studied. *Culex tarsalis* Coq., *Aëdes dorsalis* (Mg.), *Culiseta inornata* (Will.), *A. vexans* (Mg.), and *A. nigromaculis* (Ludl.), which are cited in order of abundance, constituted 99 per cent. of the 40,617 fourth-instar larvae and pupae of the 12 species collected and identified. *Culex tarsalis* was found developing from 7th May to 29th October, *A. dorsalis* from 3rd June to 8th October, *Culiseta inornata* from 21st April to 26th November and *A. vexans* and *A. nigromaculis* from 3rd June to 13th September. Seepage areas and temporary surface pools associated with irrigation were the most important sources. *Culex tarsalis* was the most abundant species in the seepage areas and was commonly found in association with *Culiseta inornata*. *A. dorsalis* was dominant in the temporary surface pools and was generally associated with *A. vexans* and *A. nigromaculis*. It is concluded that permanent control of mosquitos in the district will involve the elimination of seepage areas and surface pools on irrigated pastures.

Mattingly (P. F.). **Genetical aspects of the *Aëdes aegypti* problem. II. Disease relationships, genetics and control.**—*Ann. trop. Med. Parasit.* **52** no. 1 pp. 5–17, 63 refs. Liverpool, 1958.

In the first paper of this series, three colour forms of *Aëdes aegypti* (L.) with correlated behaviour differences were distinguished, and it was noted that only the black African subspecies, known as *formosus* (Wlk.), appears to be capable of forming fully wild populations [*R.A.E.*, B **47** 19]. The following is based on the author's summary. In this second paper the risk of the establishment of wild populations is considered; existing information on the genetics of the three forms is discussed, and the inadequacy of the contribution thus made to the problem is shown, the contribution that field studies on population genetics could make is suggested, and the imperfectly understood natural history of yellow fever in Africa is briefly

discussed, with reference to the three forms. An attempt is made to relate the differences in behaviour of the three forms to problems of control, and particular consideration is given to the effect of control measures directed against domestic forms on breeding in natural sites; it is concluded that in view of present ignorance of the nature of the transmission cycle of yellow fever in East Africa, interference with the balance between wild and domestic forms there is at present undesirable.

FAIRBAIRN (H.). **The penetration of** *Trypanosoma rhodesiense* **through the peritrophic membrane of** *Glossina palpalis*.—*Ann. trop. Med. Parasit.* **52** no. 1 pp. 18–19, 2 pls., 5 refs. Liverpool, 1958.

Observations on *Trypanosoma rhodesiense* in *Glossina palpalis* (R.-D.) showed that, in addition to reaching the space between the annular pad of epithelial cells and the invaginated part of the foregut by passing through the fluid secretion from which the peritrophic membrane is formed [*cf. R.A.E.*, B **21** 204], the trypanosomes also pass through the membrane where it lines the midgut near the junction of the dorsal wall of the latter with the roof of the proventriculus and is apparently still sufficiently fluid for trypanosomes to penetrate.

DUKE (B. O. L.). **Studies on the biting habits of** *Chrysops*. **V. The biting-cycles and infection rates of** *C. silacea*, *C. dimidiata*, *C. langi* **and** *C. centurionis* **at canopy level in the rain-forest at Bombe, British Cameroons.**—*Ann. trop. Med. Parasit.* **52** no. 1 pp. 24–35, 5 graphs, 14 refs. Liverpool, 1958.

In continuation of studies on the biting habits of species of *Chrysops* at and near Kumba, in the British Cameroons [*cf. R.A.E.*, B **45** 200, etc.], 24-hour catches were made at intervals over a period of two years on a canopy platform at a height of 85 ft. in a large, remote stretch of virgin rain-forest on a river bank opposite Bombe village about 20 miles from Kumba. Five species of *Chrysops* had been bred from larvae taken in the forest, adults of two species could be caught in numbers at ground level near a wood fire [*cf.* **45** 82], and drills (*Mandrillus leucophaeus*) and other canopy-dwelling monkeys (*Cercopithecus nictitans martini* and *C. mona mona*), many of them infected with *Loa*, were plentiful. The species of *Chrysops* occurring at ground level were *C. silacea* Aust. and a fly referred to as the Bombe form of *C. dimidiata* Wulp. The latter is morphologically intermediate between *C. silacea* and *C. dimidiata*, and its exact taxonomic position is uncertain. Typical *C. dimidiata* has not been observed by the author at Bombe or Kumba, and references to *C. dimidiata* below apply to the Bombe form. During 40 days' catching on the platform in November and December 1955, 111 individuals of *C. silacea* and 101 of *C. dimidiata* were taken; the same catches and 16 days' catching in November and December 1954 together yielded 109 individuals of *C. langi* Beq. and 37 of *C. centurionis* Aust. *C. longicornis* Macq., the fifth species bred from larvae taken in the forest, was not taken, and its biting habits there remain unknown.

The total and maximal periods of activity of *C. silacea* were about an hour later than those of *C. dimidiata*, which was caught between the first hour after sunrise and the hour before sunset, with maximal numbers during the hour before noon and the second hour before sunset, whereas *C. langi* and *C. centurionis* were crepuscular, showing a single sharp wave

of activity with the peak just before sunset in the first species and just after it in the second. Three prolonged periods of catching at different seasons in 1955 (the beginning of the rains in March–May, the height of the rains in August–October and the end of the rains in November–December) showed that all four species were present during the three seasons, but were plentiful only at the end of the rains and least often taken at the height of them. No individuals of *Chrysops* were taken in catches made, between mid-January and early March from 4 to 10 p.m. only, to determine whether *C. langi* or *C. centurionis* was active during the dry season. The incidence of infection with *Loa* among flies caught on the platform was found to be higher in *C. langi* and *C. centurionis* (12·6 and 31·8 per cent. of flies infected, respectively) than in *C. silacea* and *C. dimidiata* (4·7 and 3 per cent. infected), but the mean number of filaria larvae developing per infected feed was much smaller in the first two species. It is concluded that *C. langi* and *C. centurionis*, which bite only in the canopy and around sunset, probably obtain their blood-meals almost entirely from monkeys and are the natural vectors of the nocturnally periodic form of *Loa* found in them [*cf.* **43** 123; **46** 69–70].

Wharton (R. H.) & Santa Maria (F. L.). **Studies on filariasis in Malaya: the effect of residual insecticides on** *Mansonia* (*Mansonioides*) *longipalpis*.—*Ann. trop. Med. Parasit.* **52** no. 1 pp. 93–102, 1 graph, 14 refs. Liverpool, 1958.

The following is based almost entirely on the authors' summary. An account is given of experiments made to compare the effect of DDT, dieldrin and γ BHC on the behaviour and mortality, in man-baited huts with window traps, of mosquitos belonging to the subgenus *Mansonioides* of *Mansonia*, which include the vectors of filariasis caused by *Wuchereria malayi* in East Pahang, Malaya. Mosquitos referred to as *Mansonia longipalpis*, a name used to include both *M. dives* (Schiner) (*longipalpis* (Wulp)) and *M. bonneae* Edw. [*cf. R.A.E.*, B **47** 20], constitute most of the vectors and were the most numerous in the huts. Some observations were also made on *M. uniformis* (Theo.) and *M. annulata* Leic., which are secondary vectors. The mosquitos entered the huts at night to feed. A few remained to rest by day, but most were caught in window traps while attempting to leave before dawn the following morning. When the men were protected by a mosquito-net, a lower proportion of the mosquitos fed, and many unfed ones were in the exit traps by midnight.

The doses of insecticide tested were 50 and 100 mg. dieldrin per sq. ft., both as wettable-powder suspensions applied with a brush and in emulsion sprays, and 200 and 500 mg. DDT and 100 mg. γ BHC, all in emulsion sprays. Dieldrin at 100 mg. in either form was clearly superior to the other insecticides, giving complete kill of *M. longipalpis* for two months and maintaining a 24-hour kill of over 50 per cent. for about six months [*cf.* **44** 195]. With 50 mg. dieldrin, mortality fell below 50 per cent. in the third month after treatment, while with 100 mg. γ BHC, mortality was at first complete and fell below 50 per cent. in the fourth month after treatment. Neither the 200 mg. nor the 500 mg. dose of DDT gave complete kill initially, and the death-rate fell below 50 per cent. in the second month after treatment with 200 mg. and in the fifth month after treatment with 500 mg. The 24-hour mortality of *M. longipalpis* from the treatment with 100 mg. dieldrin per sq. ft. was the same whether the mosquitos had fed or not, and there was no difference in the mortality whether the bait was protected by a net or not. No insecticide had any obvious effect on the behaviour of *M. longipalpis* in treated huts, except

that DDT somewhat reduced the biting rate during the first month after treatment. Though the numbers of *M. uniformis* and *M. annulata* were small, the effect of the insecticides on them appeared to be very similar to the effect on *M. longipalpis*. A few examples of *Culex pipiens fatigans* Wied. were found in huts treated with 100 mg. dieldrin per sq. ft. The 24-hr. mortality was at first complete and was of more than 80 per cent. 5–6 months after treatment. The results of the experiments are briefly discussed in relation to their possible bearing on the control of filariasis transmitted by species of *Mansonioides*.

Lavoipierre (M. M. J.). **Studies on the host-parasite relationships of filarial nematodes and their arthropod hosts. I. The sites of development and the migration of** *Loa loa* **in** *Chrysops silacea*, **the escape of the infective forms from the head of the fly, and the effect of the worm on its insect host.**—*Ann. trop. Med. Parasit.* **52** no. 1 pp. 103–121, 2 pls., 14 figs., 24 refs. Liverpool, 1958.

The following is taken from the author's summary. A short account is given of the internal anatomy of *Chrysops silacea* Aust., with special reference to the respiratory and haemocoelic systems, and the sites of development and the migration of larvae of *Loa loa* in it are described. Developing forms of *L. loa* occur in oenocyte-like cells of the fat-body of the head, thorax and, especially, the abdomen, but after the first 24 hours, they burst out of the cell, and the part of the fat-body harbouring them takes on a syncytial appearance [*cf. R.A.E.*, B **47** 132]. The infective forms migrate from the abdomen to the thorax and then to the head, either through the large ventral cervical haemocoelic canal or between the oesophagus, ventral nerve-cord and cervical tracheal trunks, finding their way in either case to the subcibarial haemocoelic space. Injury caused by migrating larvae is occasionally seen in the fly's flight-muscles and certain head muscles. Though some infective larvae may emerge from the individual elements of the mouth-parts while the fly is taking a blood-meal, most of them probably escape by rupturing the labio-hypopharyngeal membrane that connects the root of the labium to the underside of the hypopharynx. As the fly drives its biting fascicle into the host's skin, the labium is retracted into the head, and the labio-hypopharyngeal membrane is stretched. The stomach soon fills with blood, displacing the contents of the abdominal air-sacs and the haemolymph forward towards the head and thorax, and it is possible that the increase in intracranial pressure and the movements of the filariae combine to rupture the labio-hypopharyngeal membrane.

Terzian (L. A.) & Stahler (N.). **A study of some effects of gamma radiation on the adults and eggs of** *Aedes aegypti*.—*Biol. Bull.* **115** no. 3 pp. 536–550, 1 graph. Lancaster, Pa., 1958.

The following is substantially the authors' summary of a study of the biological effects on *Aëdes aegypti* (L.) of γ-radiation from radioactive cobalt (^{60}Co), administered at a rate of about 450 r per minute. When normal females were mated with males that had been exposed to radiation in doses up to 30,000 r 24 hours earlier, and given a blood-meal soon after mating, egg-production was not significantly affected. If, however, mating was delayed for 8 or 15 days after irradiation of the males, egg-production

decreased and the period of oviposition increased, apparently because fewer males could copulate even though they still contained motile spermatozoa. Although eggs were still produced in some quantity whether mating was immediate or delayed, fewer larvae hatched from eggs produced by females mated to males exposed to 2,500 r or more, and very few larvae, or none, hatched from eggs produced from matings in which the males had received 10,000 r or more. Larvae that could be reared to fertile adults capable of mating and producing viable eggs were not produced from matings in which the males had received more than 7,500 r. The egg-production of females exposed to γ-radiation and mated 24 hours later to normal males was significantly reduced among those receiving 2,500 r and almost entirely inhibited among those exposed to 10,000 r. Larvae that could develop to fertile adults were not obtained from eggs produced by females exposed to more than 5,000 r. When mating was delayed for 8 or 15 days, no eggs were produced by females exposed to 5,000 r, although viable larvae hatched from eggs of females exposed to 3,500 r. Females inseminated before being exposed to radiation produced about the same number of eggs at the various dosage levels as females inseminated after exposure. However, significantly fewer larvae hatched from eggs laid by females inseminated before exposure than from eggs laid by females inseminated after exposure.

To determine the effects of radiation during the cycle of egg-development that occurs in *A. aegypti* after a blood-meal, inseminated females were exposed to γ-radiation at various intervals following engorgement. Egg-production was almost entirely inhibited in females exposed to 10,000 r four hours after a blood-meal, whereas more than 100,000 r were needed to inhibit egg-production in females exposed 42 hours after the blood-meal. On the other hand, although the amount of irradiation needed to inhibit egg-production increased as the interval between the blood-meal and irradiation lengthened, the eggs became more and more sensitive to radiation as they matured within the body. Thus, whereas viable larvae giving rise to fertile adults developed from eggs produced by females exposed to 5,000 r 4 or 24 hours after the blood-meal, such larvae did not develop from the eggs of females exposed to more than 3,500 r when exposure was delayed for 42 hours. Finally, although the dosage required to inhibit hatching of eggs exposed to γ-radiation varied enormously according to the age of the egg, eggs 2 and 16 days old exposed to more than 2,000 r failed to give rise to adults. Again, however, as in the experiments in which either males or females were exposed to radiation, whenever larvae could be reared successfully to adults, these proved to be fertile and capable of producing viable eggs if they were physically able to mate.

Papers noticed by Title only.

Mariani (M.). **Dieci anni di ricerche sulla resistenza degli insetti agli insetticidi di sintesi. Rivista critica e repertorio bibliografico.** [Ten years of research on the resistance of insects to synthetic insecticides (largely DDT). A critical review and bibliography.]—*Atti Accad. Palermo* (4) **18** pt. 1 pp. 129–211, 1 pl., 590 refs. Palermo, 1959.

Usinger (R. L.) & Ferris (G. F.). **Insects of Micronesia. Vol. 7 no. 5. Heteroptera: Cimicidae.**—pp. [3+] 285–286, 1 fig., 1 map. Honolulu, Bishop Mus., 1960. Stone (A.). **Vol. 13 no. 3. Diptera: Tabanidae.**—pp. [3+] 51–53, 1 map. 1960. [*Cf. R.A.E.*, B **45** 87; **48** 64.]

Knutson (H.), Afifi (S. E. D.) & Gray (T. M.). **Reproductive potential in relatively isolated house fly populations following repeated insecticide applications.**—*J. Kans. ent. Soc.* **31** no. 4 pp. 257–266, 5 refs. Manhattan, Kans., 1958.

An account is given of observations on the biological changes and development of resistance in a field population of *Musca domestica* L. that followed successive exposures to dieldrin deposits. Potential resting and breeding areas, on a relatively isolated ranch in eastern Kansas on which virtually no chlorinated or organophosphorus insecticides had previously been used, were treated with 0·5 per cent. dieldrin in an emulsion spray twice in 1954, twice in 1955 and once in 1956. Collections of adult flies were made before spraying (0T), after each of the 1954 sprayings (1T and 2T), after overwintering of 2T (2Tw), after the first spraying in 1955 (3T), early in 1956 after the second spraying in 1955 and overwintering (4Tw) and after the final spraying in 1956 (5T); comparison of progeny production was made with flies of the first generation reared in the laboratory, at about 80°F. from flies collected in the field. Resistance to dieldrin increased throughout the three years, but dropped after each winter. The number of adults produced per female parent decreased after the 1954–55 winter but returned to the original level after the first spraying in 1955, at which level it remained until it decreased after the last spraying, in the third year. Percentage survival during development (measured in the second and third years only) and length of adult life improved between the 2Tw and 3T collections, fell off after the winter and fell still further in the 5T collection, but the reduction in length of adult life was not marked in the last period. Weight showed a similar trend except for an increase after the final spraying.

A more detailed comparison of the 4Tw and 5T samples showed that the two groups produced about the same number of eggs over the total life-span, but the overwintered flies produced more during the first ten days. Length of adult life was always slightly, but not significantly, greater in the overwintered population, and viability of eggs laid during the first week of adult life and survival were significantly greater in this population. The superiority shown by the overwintered population in these respects resulted in the production of twice as many adult offspring by the 4Tw as by the 5T population.

A comparison of the results of this investigation with those of earlier studies of two relatively isolated, insecticide-susceptible field populations [*R.A.E.*, B **47** 28] and an insecticide-susceptible laboratory-reared strain before and after treatment in the larval stage with malathion [**46** 140] showed that egg-production was lower in the field populations than the laboratory ones and lowest in the highly dieldrin-resistant 5T population of the present work. Laboratory populations and 5T lived about the same length of time and the other field populations longer. Eggs of all populations were about equal in viability. Percentage pupation was much lower among larvae of the field than in those of the laboratory-reared populations, and the same was true in a smaller degree of survival from pupa to adult. Over-all survival from egg to adult and number of adult offspring per female parent were much lower in the field populations, the adult progeny produced being least numerous in 5T.

In view of the differences found in reproductive potential and survival between field and laboratory populations and the changes that can occur following treatment or overwintering, control measures may be expected to vary in effectiveness, not only because of over-all differences between populations, but also because of differences in reproductive potential at the

particular stage of the life-cycle at which the insecticide is directed and the season of the year at which it is applied.

Hughes (L. E.) & Philip (C. B.). **Experimental tick paralysis in laboratory animals and native Montana rodents.**—*Proc. Soc. exp. Biol.* **99** pp. 316–319, 4 refs. New York, N. Y., 1958.

Rapidly engorging females of *Dermacentor andersoni* Stiles are a well-known cause of tick paralysis of man and some animals in parts of the western United States and Canada [*cf. R.A.E.*, B **46** 104–105, etc.], but although millions of ticks in various stages, including wild-caught adults, were fed on rabbits and guineapigs during the preparation of vaccine against spotted fever, cases of recognisable paralysis in these hosts were very rare. Systematic attempts to produce the condition experimentally were therefore seldom made. However, following Gregson's successful induction of paralysis in marmots (*Marmota*) and ground squirrels (*Citellus*) [**47** 197], the susceptibility of small mammals was investigated further in western Montana with *D. andersoni* collected locally and in British Columbia. Hamsters bitten by F_1 adult progeny of ticks from British Columbia that had caused paralysis in dogs became affected by a readily recognised partial or complete paralysis, and investigations failed to reveal the presence of an infective agent or any significant gross lesions. Gregson's observations were confirmed by the development of paralysis in each of 11 local marmots (*M. flaviventris*) and 13 of 15 ground squirrels (*C. columbianus*) in addition to hamsters, following attachment of not more than eight pairs of ticks caught in British Columbia, but no paralysis was caused in rabbits, cats or white rats, even though some of the ticks were partly fed ones transferred from paralysed hamsters. On the other hand, three young wood-rats (*Neotoma cinerea*) died 4–7 days after attachment of four pairs of the Canadian ticks on each. An unexpected result was the death of 11 of 18 guineapigs 7–8 days after the attachment on each of four pairs of ticks from British Columbia, after illness lasting less than ten hours, and of one of six on the tenth day after being bitten by ticks from Montana. The latter caused paralysis in 18 of 54 hamsters, a somewhat lower percentage than the Canadian ticks. Single ticks that had become one-third or more engorged after feeding for four or more days on fatally affected hamsters produced death in fresh hamsters in only 12 hours after reattachment, and a guineapig died 21 hours after the attachment on it of two half-fed ticks from a fatally affected hamster. Male ticks alone caused no paralysis in young hamsters. Suspensions of salivary glands from engorged, innocuous females and from fed males produced at most temporary uneasiness in dogs and hamsters when injected intraperitoneally. Many animals from which ticks were removed early in illness recovered fully, and five hamsters recovered spontaneously while ticks were still attached.

These observations suggest that the use of hamsters will make possible a more intensive study of the active principle responsible for tick paralysis and the determination of its relationship, if any, to the toxic principle reported by Steinhaus in the egg of *D. andersoni* [**31** 137; *cf.* also **47** 88]. Ecological or genetic factors may be involved, or both, and it is noteworthy that reared progeny of paralysis-producing ticks induced experimental disease. In spite of the occurrence of paralysis in many of the experiments described after attachment of partly fed ticks from paralysed animals, individual female ticks that had produced paralysis in three children

completed engorgement and mated on two dogs and one hamster, respectively, in 2–4 days, without producing signs of paralysis in these hosts. Hamsters were used to test laboratory stocks of *D. andersoni*, *D. variabilis* (Say) and *Rhipicephalus sanguineus* (Latr.) of an Egyptian strain as well as *D. occidentalis* Marx caught in nature in Oregon, but were not paralysed, though three of ten tests with *R. sanguineus* were equivocal.

Baer (H. W.). **Winterfänge von *Anopheles*-Mücken.** [Winter catches of Anopheline mosquitos.]—*Angew. Parasit.* **1** pt. 1 pp. 8–11, 7 refs. Jena, 1960. (With summaries in English & Russian.)

The following is based on the author's summary. Winter control of Anophelines depends on a knowledge of their overwintering habits, and such information is given for those that occur in Germany. *Anopheles labranchiae atroparvus* van Thiel, *A. maculipennis maculipennis* Mg., and *A. m. messeae* Flni. hibernate as adults in attics, barns, sheds, cellars and other sheltered places, but *A. claviger* (Mg.) (*bifurcatus*, auct.) and *A. algeriensis* Theo. pass the winter as larvae in their breeding places and *A. plumbeus* Steph. (*nigripes* Staeg.) usually overwinters in the egg.

Platt (R. B.), Love (G. J.) & Williams (E. L.). **A positive correlation between relative humidity and the distribution and abundance of *Aedes vexans*.**—*Ecology* **39** no. 1 pp. 167–169, 1 graph, 8 refs. Brooklyn, N. Y., 1958.

An account is given of a study in Georgia of the relations between mosquito activity through the night and various environmental factors. The observations were made at two wooden towers 50 ft. high, one situated in an open field and one in dense woodland and both equipped for the recording of humidity and temperature at heights of 0, 3, 6, 15 and 50 ft. and wind speeds at 3 and 50 ft., and having gauges for recording rain and surface water levels near their bases. A battery of 12 light-traps was operated on each tower, one night per week sequentially at 6, 15 and 40 ft. The 12 traps were operated consecutively for one hour each from 6 p.m. to 6 a.m. *Aëdes vexans* (Mg.) was the only species caught in sufficient numbers to provide data for correlation studies, and from January 1956 to June 1957, only 17 collections of this species were adequate for analysis. The collections were about evenly divided between the two habitats and the three levels and were scattered through spring, summer and autumn. For each, there was a positive correlation between relative humidity and maximum catch through the night, numbers increasing until an optimum relative humidity of 70 per cent. (in 8 collections) or between 60 and 90 per cent. (in 9 collections) was reached. There was no correlation between catch and any of the other environmental factors measured or with any combination of them. When the collecting period was extended to three hours, no precise correlations could be obtained.

Blum (M. S.), Pratt jr. (J. J.) & Bornstein (J.). **Fluorinated analogs of DDT as toxicants and DDT synergists.**—*J. econ. Ent.* **52** no. 4 pp. 626–628, 8 refs. Menasha, Wis., 1959.

The following is almost entirely based on the authors' abstract. The insecticidal activities of 16 fluorine-containing structural analogues of DDT and their ability to act as DDT synergists were determined. In tests of

synergism, one part analogue was mixed with five parts DDT. Of the 1,1-di(p-halophenyl)-2,2-difluoro derivatives of ethane, the p-bromo and p-chloro compounds were about equally toxic to susceptible house-flies (*Musca domestica* L.) though much less toxic than DDT, and the p-fluoro compound was still less effective. The corresponding ethanol and ethyl-acetate derivatives showed the same relations to each other, and were progressively less toxic than those of ethane. The 1,1-di(p-halophenyl)-2-fluoroethenes and all the unsubstituted diphenyl derivatives were not significantly toxic. Maximum synergistic activity with DDT against flies of a resistant strain occurred in those derivatives containing p-chloro- or bromo- groups, fluoro- being inferior in all cases. Synergistic activity varied with the nature of the group attached to the α carbon atom in the following order: $OH > H > OCOCH_3$. The diphenylfluoroethenes were the least active p-halophenyl synergists. The diphenyldifluoro compounds containing no halogen substituent in the benzene ring were devoid of synergistic activity. The fluoro derivatives of ethane, ethanol and ethyl acetate containing p-chloro- or bromo- groups were all more active as synergists than 1,1-di(p-chlorophenyl)ethanol (DMC) or ethene and practically as effective as or more effective than 1,1-di(p-chlorophenyl)ethane, which are all well-known DDT synergists and were included for comparison.

McComb (C. W.) & Bickley (W. E.). **Observations on black flies in two Maryland counties.**—*J. econ. Ent.* **52** no. 4 pp. 629–632, 1 fig., 9 refs. Menasha, Wis., 1959.

The following is largely based on the authors' abstract. In recent years, residents of the Maryland suburbs of Washington, D.C., have been troubled by small non-biting flies that swarm round the head and enter the eyes, ears, nose and mouth. Surveys were carried out during 1956 and 1957 to identify the flies, some of which were known to be Simuliids, and to study their ecology and distribution in the metropolitan areas of two Maryland counties. In 1956, attempts were made to study the habits of the adults on 215 occasions at 43 stations, and on 92 of these occasions collections were made at 21 stations. Adults of *Simulium jenningsi* Mall. were collected at 18 stations and were present at one or more of them during each ten-day period from May to November. There were 186 different observations on larvae at 40 stations during 1956, with collections made at 36 stations; 42 observations were negative. Larvae of *S. jenningsi* were collected at only five stations, four of which were in the Potomac River. Additional observations in 1957 provided further evidence that *S. jenningsi* was the predominant species. Adults were common throughout the metropolitan areas, but larvae were found almost exclusively in the Potomac River where they were associated with waterwillow (*Dianthera americana*). It appears that there are two principal generations, which usually emerge early in May and early in June. A few pupae of *S. luggeri* Nicholson & Mickel were found, some of them in close proximity to those of *S. jenningsi*. This Simuliid was described as a subspecies of *S. jenningsi* and can be distinguished from it only in the pupal stage, but the observed association of pupae of the two suggests that it is a distinct species.

Ten other species of Simuliids were collected during the surveys. Females of *S. decorum* Wlk., *S. venustum* Say and *S. parnassum* Mall. were recorded as biting man, but the last was rare. Other species represented in moderate numbers were *S. vittatum* Zett. and *Prosimulium hirtipes* (Fries) and, in the larval stage only, *Simulium tuberosum* (Lndst.). Adults of two species of *Hippelates* and some Drosophilids were collected occasionally. Various formulations of DDT, malathion or γ BHC (lindane) were used in fog

machines, and a formulation of γ BHC and one of BHC and DDT were used in mist blowers for the control of adults. Relief from annoyance lasted for only a few hours, probably because areas of only 500 acres were treated.

Monroe (R. E.) & Robbins (W. E.). **Studies on the mode of action of synergized Bayer 21/199 and its corresponding phosphate in the house fly.**—*J. econ. Ent.* **52** no. 4 pp. 643–647, 6 graphs, 20 refs. Menasha, Wis., 1959.

The following is largely based on the authors' summary and discussion. The toxicity and the *in vitro* and *in vivo* anticholinesterase activity of Bayer 21/199 (O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl phosphorothioate) and the corresponding phosphate (O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl phosphate), with and without piperonyl butoxide, were studied in house-flies (*Musca domestica* L.) of a strain moderately resistant to DDT. The two phosphorus compounds were equally toxic when administered topically to the flies, the LD50 being 0·107 μg. per fly, and both were about 2·8 times more toxic when administered jointly with piperonyl butoxide at an insecticide : synergist ratio of 1 : 10. The piperonyl butoxide alone at 10 μg. per fly was non-toxic. The phosphate was 435 times more potent than the phosphorothioate as an anticholinesterase agent *in vitro*. The addition of piperonyl butoxide did not increase the anticholinesterase activity of either compound *in vitro*, but markedly increased that of the phosphorothioate *in vivo*. It thus appears that the latter is either non-toxic or only slightly toxic to *M. domestica* and is converted to its corresponding phosphate *in vivo*, and that piperonyl butoxide is not associated with its oxidative metabolism. Organic phosphates are generally more susceptible to hydrolysis than the corresponding phosphorothioates and, being better phosphorylating agents, are more potent *in vitro* anticholinesterase agents. Therefore the difference between the *in vivo* and *in vitro* activities of 21/199 and its phosphate may be due either to differences in rates and routes of absorption or to their relative stability in the biological system [*cf.* next abstract but one]. It is suggested that, if a toxicant is administered alone, only a part is available to phosphorylate cholinesterase at the final site of action before it is hydrolysed or excreted, but if it is administered with a synergist, there will be competition between the two for identical sites of loss, so that more toxicant will remain in the organism and ultimately more of it will phosphorylate the enzyme and so cause a higher mortality. Cholinesterase inhibition was reversible in flies treated with 21/199 with or without piperonyl butoxide.

Burns (E. C.), McCraine (S. E.) & Moody (D. W.). **Ronnel and Co-Ral for horn fly control on cable type back rubbers.**—*J. econ. Ent.* **52** no. 4 pp. 648–650, 3 graphs, 2 refs. Menasha, Wis., 1959.

Co-Ral (O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl phosphorothioate) at 0·25 per cent. and ronnel [O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate] at 1 per cent. in oil solution were compared with 5 per cent. toxaphene on cable-type back rubbers [*R.A.E.*, B **40** 131] for the control of *Siphona irritans* (L.) on cattle. The rubbers were treated with 6 U.S. quarts solution at the beginning of the experiment (23rd May), and re-treated fortnightly until 20th June and once again on 18th July; the experiment ended on 31st July. The results, which are presented graphically, showed that both insecticides compared favourably with toxaphene. Rubbers

treated fortnightly with the latter kept numbers of *S. irritans* low, but populations increased sharply when re-treatment was delayed beyond two weeks. Co-Ral and ronnel both effectively reduced higher populations of *Siphona* than were exposed to toxaphene, but numbers increased again when re-treatment was delayed, though to a lower level. Ronnel effected the greatest reduction in populations and permitted the least reinfestation.

Robbins (W. E.), Hopkins (T. L.) & Darrow (D. I.). **Synergistic action of piperonyl butoxide with Bayer 21/199 and its corresponding phosphate in mice.**—*J. econ. Ent.* **52** no. 4 pp. 660–663, 10 refs. Menasha, Wis., 1959.

The following is based almost entirely on the authors' discussion. Bayer 21/199 (O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl phosphorothioate) and the corresponding phosphate were about equally toxic to mice when administered orally either alone or with piperonyl butoxide at a toxicant: synergist ratio of 1:5, although the phosphate was several thousand times as potent an anticholinesterase agent as the parent compound against mouse-brain cholinesterase *in vitro*. The differences are probably due in part to the lower stability of the phosphate to hydrolysis [*cf.* preceding abstract but one]. The toxicity of both compounds was increased four to six times by their joint administration with piperonyl butoxide, and this was shown not to be due to enhanced absorption of the toxicant from the digestive tract in the presence of the synergist because the toxicity of 21/199 administered with piperonyl butoxide was equally raised when it was taken orally and the synergist intraperitoneally [*cf. R.A.E.*, B **41** 61].

An increase in the *in vivo* but not in the *in vitro* anticholinesterase activity produced by piperonyl butoxide with both compounds and a lack of either *in vivo* or *in vitro* anticholinesterase activity in the synergist indicate that its mode of action differs from that of the toxicants. This was further substantiated by studies of metabolism with 21/199 labelled with ^{32}P, in which the joint application of synergist and toxicant resulted in a more widespread distribution and higher concentrations of labelled organosoluble compounds in the tissues. These observations indicate that the synergist may increase toxicity by blocking the metabolism of the toxicant [*cf.* preceding abstract but one]. This has been postulated as the mode of action of piperonyl butoxide in synergism with pyrethrins [*cf.* **41** 62]. A more potent anticholinesterase agent that behaved chromatographically like the phosphate was formed *in vivo* and *in vitro* from 21/199, and this suggests that the phosphorothioate exerts its toxic action following *in vivo* conversion to the phosphate.

Adkins jr. (T. R.) & Arant (F. S.). **A technique for the maintenance of a laboratory colony of *Cimex lectularius* L. on rabbits.**—*J. econ. Ent.* **52** no. 4 pp. 685–686, 5 refs. Menasha, Wis., 1959.

A technique is described whereby several thousand fifth-instar nymphs of *Cimex lectularius* L. were produced every month in Alabama for use in bioassay. The bugs were kept in glass beakers that contained disks of paper towelling as repositories for eggs and were stored at 26·7°C. [about 80°F.] and 26 per cent. relative humidity. For feeding, adults, and the disks, were transferred to Pyrex cylinders closed at both ends with nylon hosiery material, through which access was given to the shaved abdomen of a rabbit for 30 minutes three times a week; once a week, the disks containing eggs were removed to separate beakers, instead of being returned

with the adults, and left for the eggs to hatch. After hatching, the nymphs were given the opportunity to feed four times at intervals of about two days and then three times at intervals of ten days. By the end of this time, most were in the fifth instar and a few had given rise to adults. The adults were kept for breeding, and most of the nymphs were used in experiments. Any nymphs that were not needed were fed again to produce more adults for the breeding colony. Fed adults were separated from the nylon or from the disks by anaesthetisation for a few seconds, which made them relax their hold.

O'Brien (R. D.) & Wolfe (L. S.). **The metabolism of Co-Ral (Bayer 21/199) by tissues of the house fly, cattle grub, ox, rat, and mouse.**—*J. econ. Ent.* **52** no. 4 pp. 692–695, 5 figs., 15 refs. Menasha, Wis., 1959.

Bayer 21/199 (O,O-diethyl O-3-chloro-4-methyl-7-coumarinyl phosphorothioate) is highly toxic to larvae of *Hypoderma* spp. when applied dermally to cattle infested with them (though not when applied orally, according to a report by D. MacDougall [*cf.* also *R.A.E.*, B **47** 138]), and it is only slightly toxic to the cattle themselves. The study described was undertaken to establish whether this selective toxicity could be accounted for by differences in the balance of toxifying and detoxifying systems in various kinds of animals, as has already been shown for malathion [**45** 77; **46** 79–80] and acethion [O,O-diethyl S-ethoxycarbonylmethyl phosphorodithioate] [**48** 25–26]. The LD50's of 21/199 for house-flies (*Musca domestica* L.) and for mice and rats by intraperitoneal injection were found to be 1·5, 23·5 and 150 mg. per kg., respectively. Thus house-flies and mice can be classed with *Hypoderma* larvae as susceptible, whereas rats, like cattle, are not. In mammals, the liver was the only organ of those studied that was of importance in the metabolism of the chemical. There appeared to be excellent correlation between anticholinesterase activity after exposure of 21/199 to the action of liver slices and its toxicity, the compound being activated by mouse liver and degraded by that of ox or rat. There appears to be no degrading system in the mouse, but in the ox, both activating and degrading systems have been shown, in microsomes [*cf.* **46** 80; **47** 26] and homogenates, respectively, the degrading system being the more potent. Both the adult of *M. domestica* and the larva of *Hypoderma bovis* (Deg.) appear to have an activating but no degrading system. However, the activating system of the larva is weak compared with that of the house-fly and was detected by only one technique, in which the concentration of 21/199 was 50 times greater than in three others. The activating capacity of *Hypoderma* larvae is associated with fat-body and gut [*cf.* **46** 80]. The results account for the selective toxicity of 21/199 and possibly for the ineffective control of *Hypoderma* by the oral dosing of cattle, which allows the liver to inactivate the compound before it reaches the larva.

Darsie jr. (R. F.) & Corriden (F. E.). **The toxicity of malathion to killifish (Cyprinodontidae) in Delaware.**—*J. econ. Ent.* **52** no. 4 pp. 696–700, 1 fig., 15 refs. Menasha, Wis., 1959.

The following is taken from the authors' abstract. In a series of field tests to ascertain the toxicity of malathion, as applied in mosquito control, to Cyprinodontid fish (killifish) in tidal marshes in Delaware, about 26 per cent. mortality was caused in the species *Fundulus ocellaris* in four

hours by exposure to 0·5 lb. malathion per acre sprayed in oil solution from aircraft, and about 31 per cent. of the fish were unaffected. Among affected fish kept under observation for a further 60 hours, 66 per cent. recovered and 26 per cent. died, the remainder still showing symptoms.

Wilson (H. G.) & LaBrecque (G. C.). **Evaluation of some space sprays for the control of house flies.**—*J. econ. Ent.* **52** no. 4 pp. 704–706. Menasha, Wis., 1959.

Four organophosphates and four chrysanthemates were tested for toxicity to house-flies (*Musca domestica* L.), in comparison with allethrin and pyrethrins synergised with ten times as much piperonyl butoxide, at 3–5 concentrations in a wind tunnel and 1–3 in a spray chamber, and on the basis of the results, single concentrations of three organophosphorus compounds, three chrysanthemates and the synergised allethrin and pyrethrins were applied in dairy barns. Solutions in odourless kerosene were applied five days a week at 1 ml. per 50 cu. ft. in all fly-infested areas. All treatments gave considerable knockdown (usually over 90 per cent.) in ten minutes, but none gave good control after 24 hours, and populations had been only slightly reduced at the end of three weeks.

Sherman (M.) & Ross (E.). **Toxicity of house fly larvae to insecticides administered as single oral dosages to chicks.**—*J. econ. Ent.* **52** no. 4 pp. 719–723, 1 fig., 14 refs. Menasha, Wis., 1959.

The following is almost entirely based on the authors' abstract. The acute toxicity of diazinon, trichlorphon (Dipterex), Dow ET-14 (O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate), Dow ET-15 (O-methyl O-2,4,5-trichlorophenyl phosphoramidothioate), malathion and phenothiazine to chicks one week old and the toxicity of the droppings from treated chicks to first-instar larvae of *Musca domestica* L. were investigated. The LD50's, seven days after treatment, expressed as mg. technical toxicant per kg. body weight of the chicks, were 8·4 for diazinon, 65 for trichlorphon, 370 for malathion, 890 for ET-14 and 1,180 for ET-15. Phenothiazine was non-toxic at 1,970 mg. per kg., the maximum measured dose that could be introduced into the crop without loss of test material. ET-14 and ET-15 had an anaesthetising effect that was reflected in lower gains of weight even at levels that caused no mortality, but none of the other compounds affected gain in weight at non-lethal dosages.

The toxicity of the droppings to house-fly larvae introduced into them in the laboratory was related directly to the dosage of insecticide ingested by the chick and inversely to the time that elapsed between their ingestion of the insecticide and their voiding of the droppings. Droppings collected daily from chicks receiving non-lethal doses of malathion, trichlorphon, ET-14 and ET-15 caused more than 90 per cent. kill of larvae for 1, 2, 3 and 6 days, respectively, but those from diazinon- and phenothiazine-treated chicks caused relatively low mortality.

Forgash (A. J.) & Hansens (E. J.). **Cross resistance in a diazinon-resistant strain of *Musca domestica* (L.).**—*J. econ. Ent.* **52** no. 4 pp. 733–739, 5 figs., 34 refs. Menasha, Wis., 1959.

Resistance to diazinon poses a serious problem in the control of *Musca domestica* L. in several countries because of accompanying cross-resistance

to other insecticides. The following is substantially the authors' summary of a study in New Jersey of the extent of this cross-resistance, undertaken to help the search for chemicals suitable for control of insects resistant to diazinon. Laboratory selection of a diazinon-resistant field strain of *M. domestica* by exposure to diazinon-treated panels for nine generations increased resistance not only to diazinon but to a wide variety of insecticides. The materials tested, with (in brackets) the factor by which the tolerance of the resistant strain at the LD50 level, as determined by topical application of the material in acetone, exceeded that of a normally susceptible strain, were diazinon (38), parathion (16), ronnel [O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate] (18), Chlorthion (23), malathion (5), Sevin (more than 37), Isolan (14), Pyrolan (10), chlordane (400), dieldrin (220), γ BHC (lindane) (250), DDT (more than 6,400), p,p'DDD (TDE) (more than 1,300), p,p'methoxy-DDT (methoxychlor) (more than 3,600), Dilan (a 1:2 mixture of Prolan and Bulan) (10), allethrin (5), pyrethrins (4) and Lethane 384 (β-butoxy-β'-thiocyanodiethyl ether) (2). The small decreases in susceptibility to Lethane, pyrethrins, allethrin and malathion may be simply instances of vigour tolerance [*R.A.E.*, B **47** 72]. All the others are considered to be examples of true resistance. The extent of cross-resistance indicates that most of the materials in current use will be ineffective against diazinon-resistant flies. It is suggested that phosphorodithioates, more stable carbamates or more toxic thiocyanates may offer promise. Tests on resistant flies collected from the field without further selection with diazinon indicate that the pattern of cross-resistance observed is very similar to that occurring under completely natural conditions of selection.

Fukuto (T. R.) & Metcalf (R. L.). **Insecticidal activity of the enantiomorphs of O-ethyl S-2-(ethylthio)ethyl ethylphosphonothiolate.**—*J. econ. Ent.* **52** no. 4 pp. 739–740, 8 refs. Menasha, Wis., 1959.

Tests with the *dextro*, *laevo* and racemic forms of O-ethyl S-2-(ethylthio)-ethyl ethylphosphonothioate showed that the *laevo* isomer was 6, 9·7 and 10 times as toxic by contact as the *dextro* isomer to adults of *Musca domestica* L. and honey-bees and the larvae of *Culex pipiens fatigans* Wied. (*quinquefasciatus*, auct.), respectively, and inactivated fly-brain cholinesterase 11 times as rapidly; the racemic form gave values approximating to the means for the two resolved forms. It is clear that the toxicity of these compounds closely parallels the rates at which they inactivate cholinesterase.

Drummond (R. O.) & Graham (O. H.). **Dowco 109 as an animal systemic insecticide.**—*J. econ. Ent.* **52** no. 4 pp. 749–750, 4 refs. Menasha, Wis., 1959.

Dowco 109 (O-methyl O-(4-tert.-butyl-2-chlorophenyl) methylphosphoramidothioate) killed larvae of *Callitroga hominivorax* (Coq.) when administered orally at 50 and 100 mg. per kg. or by subcutaneous injection at 100 mg./kg. to infested guineapigs in screening tests at Kerrville, Texas, and adults of *Stomoxys calcitrans* (L.) allowed to feed on the guineapigs four hours after treatment were killed by the oral treatments, though not by the subcutaneous one. Lower doses were ineffective. The compound also killed larvae of *C. hominivorax* one day and four days old when it was administered in water suspension as a drench to infested sheep at 50 mg. per kg. but did not do so at 20 mg. per kg. It was then tested against *Hypoderma lineatum* (Vill.) and *H. bovis* (Deg.) in cattle [*cf. R.A.E.*, B

48 16, 26, 56]. No larvae encysted in the back of a calf from South Dakota treated in the autumn of 1956 with a suspension of Dowco 109 given as an oral drench at 10 mg. per kg., but 33 encysted in one sprayed with 2 litres of a 0·25 per cent. suspension, as compared with an average of 44·4 in 16 untreated controls.

In larger-scale tests with 20 South Dakota cattle infested with both species of *Hypoderma* and treated in November 1957, intramuscular injection of 15 and 25 mg. per kg. Dowco 109 in solution and oral drenching with a suspension of a wettable powder at the same rates effected reductions of 76, 99, 92 and 94 per cent., respectively, in numbers of larvae encysting. In tests in July with Texas cattle infested with *H. lineatum* only, injection at 5 and 10 mg. per kg. and addition of the compound to the ration at 1 mg. per kg. daily for 42 days had been ineffective, but spraying [*cf.* **48** 97] at a pressure of 100 lb. per sq. inch with a 1 per cent. suspension at 2 U.S. quarts per head had reduced numbers of larvae encysting by 80 per cent., though a 0·5 per cent. spray was ineffective. R. D. Radeleff in unpublished work found that oral treatment with 100 mg. per kg. caused no signs of poisoning or serious depression of blood cholinesterase in cattle.

Hargett (L. T.) & Goulding (R. L.). **Rotenone and methoxychlor dust in back-rubbers for horn fly control in dairy herds.**—*J. econ. Ent.* **52** no. 4 pp. 762–763, 3 refs. Menasha, Wis., 1959.

As back rubbers charged with dust formulations have given promising results in the control of horn flies (*Siphona irritans* (L.)) [*R.A.E.*, B **48** 51] and as they are convenient and economical, tests were made of formulations that might fall within the dosage range at present recommended for use on dairy cattle. The rubbers were installed under shelter at the exit from the milking room so that all cows were obliged to use them. Control was considered satisfactory when the number of horn flies per cow was reduced to ten or less; untreated herds averaged about 100 flies per cow throughout the season. A 5 per cent. rotenone dust gave satisfactory control for 6–7 weeks and 5 per cent. methoxy-DDT (methoxychlor) for 3–5 weeks; a 4 per cent. malathion dust and 25 per cent. N,N-diethyl-m-toluamide [*cf.* **46** 184, etc.] each gave control for one week only. The estimates of the daily dosage of dust ranged from 0·01 to 0·03 oz. per cow. Treatment of dairy cattle at this rate with 5 per cent. rotenone dust is unlikely to result in the appearance of harmful residues in the milk, but the hazard associated with daily exposure to low dosages of methoxy-DDT needs further investigation.

Hunter (P. E.), Cutkomp (L. K.) & Kolkaila (A. M.). **Reproduction following insecticidal treatment in two resistant strains of house flies.**—*J. econ. Ent.* **52** no. 4 pp. 765–766, 1 ref. Menasha, Wis., 1959.

In earlier work [*R.A.E.*, B **48** 15–16], it was shown that treatment of the females with DDT or diazinon reduced the reproductive capacity of a DDT-resistant strain of house-flies (*Musca domestica* L.), the fecundity of the females, the fertility of their eggs and the survival of their offspring all being lower than those of non-treated flies of the same culture, but increased that of a susceptible strain in some of its phases. To determine whether the results with the DDT-resistant strain were characteristic of that strain only, two additional resistant strains were studied by similar methods [*loc. cit.*]. The LD50's of the strains were 130 μg. and 160 μg. per female for

DDT applied topically in olive oil, and that of a susceptible strain 0·5 μg. The results were in general agreement with those reported in the earlier paper and showed a similar response in each of the resistant strains studied. The reproductive capacity of the females treated with DDT or diazinon from each DDT-resistant strain was less, sometimes significantly, in all phases of reproduction, than that of untreated females, except in the fertility of the eggs of the females of one of the strains that were treated with diazinon. The lives of the survivors were shorter than those of untreated females, generally significantly. The reason for these effects is not known, but lack of vigour has been suggested.

Laake (E. W.). **The cotton rat irruption in Dallas, Texas in 1958.**—*J. econ. Ent.* **52** no. 4 pp. 770–771, 1 ref. Menasha, Wis., 1959.

In a survey of Dallas, Texas, between January 1956 and March 1957, 2·6 per cent. of 76 roof rats [*Rattus rattus*] caught were found to be infected with murine typhus, but no infection was found in 181 Norway rats [*R. norvegicus*]. Only 10 per cent. of the rats trapped were infested with *Xenopsylla cheopis* (Roths.). In a resumed survey between November 1957 and March 1958, blood from 118 Norway rats and 10 roof rats was shown to be negative for typhus by the complement-fixation test, and only 7 per cent. of all rats trapped were infested with *X. cheopis*. The reason for the apparent disappearance of typhus infection from the rats is unknown. A large outbreak of cotton rats (*Sigmodon hispidus*) in rural areas to the north of Dallas in the autumn of 1958 led to anxiety as to the part they might play in spreading typhus, and between 25th September and 5th December, nearly 300 were trapped in grass and weed-covered plots, the blood of over 100 of the larger ones was examined for typhus infection and 199 were combed for ectoparasites. No sign of typhus infection or infestation with *X. cheopis* was found. The 6,492 ectoparasites recovered included representatives of four species of mites, with *Haemolaelaps glasgowi* (Ewing) predominant, and three species of fleas. The results are believed to confirm earlier impressions that *S. hispidus* is not a reservoir of typhus.

Rodriguez (J. L.) & Riehl (L. A.). **Malathion dust for the control of two species of pigeon lice.**—*J. econ. Ent.* **52** no. 4 p. 772, 1 ref. Menasha, Wis., 1959.

Application of 0·5 or 1 per cent. malathion dust to pigeons with a small hand duster or of the 1 per cent. dust to the nests gave complete control of *Columbicola columbae* (L.) (*Lipeurus baculus* (Nitzsch)) and *Campanulotes* (*Goniocotes*) *bidentatus* (Scop.) for more than four months in southern California. Treatment of the nests is preferable because it is simpler and causes less disturbance to the flock. Neither the careful removal of eggs and young birds during treatment nor the presence of the dust adversely affected eggs or squabs or the behaviour of the adult pigeons.

Rodriguez (J. L.) & Riehl (L. A.). **Malathion dust for the control of lice on domestic game birds.**—*J. econ. Ent.* **52** no. 4 pp. 774–775. Menasha, Wis., 1959.

The high densities at which domestic game birds are kept in rearing pens in southern California favour infestation and complicate examination. The

presence of lice having been reported on several species on one ranch, birds chosen at random were examined, and one species of partridge, two species of quail and three species of pheasants were found to be infested with wing lice (*Lipeurus* sp.) and body lice (*Goniocotes* sp. and *Goniodes* sp.). As treatment of the natural dusting wallows in the pens seemed to offer promise of simple and inexpensive control, the wallows in each of nine pens containing infested birds were dusted liberally with 1 per cent. malathion. The birds involved comprised 64 partridges, 475 quail and 93 pheasants. Only a few were examined to assess results because of the danger of injury, as they were easily excited, but no lice were found on any birds from treated pens at any of the examinations, which were made 7–90 days after treatment. Infestations of both wing and body lice on three partridges from a small untreated pen remained fairly constant for 30 days, after which the birds were treated at the owner's request.

Kilpatrick (J. W.) & Schoof (H. F.). **A semiautomatic liquid fly bait dispenser.**—*J. econ. Ent.* **52** no. 4 pp. 775–776, 1 fig., 2 refs. Menasha, Wis., 1959.

Baits containing organophosphorus insecticides are effective in controlling *Musca domestica* L. in dairy barns, but the need for frequent replenishment is a disadvantage. In the experiments described, a 0·1 per cent. solution of dichlorvos (DDVP) or a 1 per cent. solution of trichlorphon (Dipterex) with 1 lb. sugar per U.S. gal. was dispensed semi-automatically from a watering device for fowls, which had a capacity of 1 U.S. gal. The device maintained a constant level of liquid in the trough at its base, which was covered with a ring of screen wire that allowed the flies to feed but prevented accumulation of their dead bodies in the trough. In mid-June, six dispensers filled with dichlorvos bait were installed in the milking barn of one dairy farm, two in the feed barn and three in the calf pens. Fly counts, which had been 86 and 177 in the preceding two weeks, fell to 43, 14, 8, 5, 7, 5 and 3 in the next seven. The index rose to 74 flies in the eighth week, but was 10 and 19 after cleaning and refilling of the dispensers. After this, control was lost because many of the dispensers were overturned. They were cleaned and filled with trichlorphon bait, after which indices remained at 7–13 flies for four weeks. At a fowl ranch, 11 dispensers filled with dichlorvos bait were distributed among the batteries in mid-June. For two weeks, there was little improvement over the pretreatment indices which were 55 and 47, but after the positions of the dispensers had been changed so that the troughs were not clogged by droppings and feathers, counts fell to 15 and 22. Cleaning and refilling of the dispensers in mid-August reduced indices to 4–12 for the next five weeks, after which they rose to 19, 26 and 47. The only attention needed by dispensers apart from refilling about every six weeks is weekly twirling of the screen ring to dislodge dead flies.

Schoof (H. F.) & Kilpatrick (J. W.). **Dilan formulations for adult house fly control.**—*J. econ. Ent.* **52** no. 4 pp. 776–777, 1 ref. Menasha, Wis., 1959.

In continued tests of Dilan (a 1:2 mixture of Prolan and Bulan) for the control of house-flies (*Musca domestica* L.) in dairies in Georgia [*cf. R.A.E.*, B **43** 191], sprays of Dilan at 200 mg. per sq. ft., Dilan:DDT at 200:200

mg. per sq. ft., Dilan : DDT : cottonseed oil at 200 : 200 : 80 mg. per sq. ft. or Dilan : cottonseed oil at 200 : 80 mg. per sq. ft. were applied in four dairies in late May. Fly-grill indices [**38** 158] were reduced markedly within one week by all the treatments. The Dilan : DDT : cottonseed oil gave satisfactory control (20 flies per grill count or less) in the first post-treatment week and indices slightly above that level for the next four. Dilan : cottonseed oil also gave only one week of satisfactory control, and Dilan : DDT failed to reduce indices to a satisfactory level at any time. Treatment with Dilan alone was followed by a progressive decline in fly densities, but indices did not fall to a satisfactory level until the fourth week; they remained satisfactory for a further four weeks and then rose rapidly. At another dairy, similarly treated, indices fell initially to an almost satisfactory level but became very high again within two weeks. The failure of the Dilan and cottonseed-oil formulations with and without DDT to give results as good as those obtained in the previous work is attributed to the fact that fly populations were naturally rising, whereas the previous experiments were begun in late summer when the populations were falling.

Kilpatrick (J. W.) & Schoof (H. F.). **The effectiveness of ronnel as a cord impregnant for house fly control.**—*J. econ. Ent.* **52** no. 4 pp. 779–780, 3 refs. Menasha, Wis., 1959.

Dow ET-57 [purified O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate] as a 25 per cent. solution of Dow ET-14 [the unpurified compound] in xylene was tested for the impregnation of cords to control house-flies (*Musca domestica* L.) in ten dairy barns in Georgia during June–August in 1957 and 1958. The cords were 3/32 inch in diameter and were used at 30 linear feet per 100 sq. ft. of floor area [*cf. R.A.E.*, B **46** 43]. In tests carried out in six barns, satisfactory or excellent control was achieved for the total duration of the various tests (8–16 weeks), except in one case in which observations were continued for 12 weeks but control ceased to be satisfactory after the ninth. In two other barns there was a rapid rise of grill indices [**38** 158] from less than ten to over 300 flies when cords that had given good control for nine or ten weeks were removed for 3–4 weeks. Reinstallation of the same cords caused densities to return to reduced levels within two weeks. In a third barn, removal of the cords after 12 weeks of control led to a moderate increase in fly densities. In only one barn did the cords fail to give satisfactory results, the index being reduced from 150 to 30 but rising again at once; substitution of newly treated cords after six weeks, when the index had reached more than 300, had little effect, and their replacement with parathion-treated cords after another six weeks also failed to provide satisfactory control; the fly potential was not exceptionally high, and no reason could be given for the poor results. It is concluded that cords treated with ET-57 offer more promise for house-fly control than deposit sprays of the same material, as the latter applied at 200 mg. per sq. ft. gave control for only 8–9 weeks [**48** 59].

Anthony (D. W.). **Tests with DDT, lindane and malathion for control of the long-nosed cattle louse** *Linognathus vituli* **(L.).**—*J. econ. Ent.* **52** no. 4 pp. 782–784, 5 refs. Menasha, Wis., 1959.

Excellent control of cattle lice with chlorinated-hydrocarbon insecticides has been reported from several States [*R.A.E.*, B **43** 117; **44** 170; **45** 43;

46 169], but the observations on *Linognathus vituli* (L.) described in this paper indicate that resistance may be developing. About half of a batch of 24 heifer calves found to be lightly infested with *L. vituli* on arrival in Maryland from south-western Virginia in May 1957 were sprayed with emulsified solution of 0·025 per cent. γ BHC (lindane) at 3–4 U.S. quarts per animal. No lice could be found one week after treatment, but light infestations were seen on 6 of 16 calves available for examination after 18 days. The animals were resprayed immediately with 0·035 per cent. γ BHC and again appeared to be free of lice one week later, but all except one were again infested, four of them heavily, after six weeks. It was subsequently learnt that the calves had received two treatments with 0·075 per cent. γ BHC in late March and at the end of April. Emulsion sprays containing 0·075 per cent. γ BHC, 0·5 per cent. DDT or 0·5 per cent. malathion were then applied to each of three groups of six of the original calves at 4–5 U.S. quarts per animal and two lightly infested calves were kept as controls. The γ BHC apparently killed all motile lice, but light infestations of nymphs and adults were observed after 14 days, and infestations as heavy as before treatment were found after 30 days. DDT gave excellent immediate control, but four of the six calves had light infestations of nymphs after seven days, and again infestations had returned to pre-treatment level after 30 days. The malathion treatments were completely effective throughout the 30-day period. There were no apparent changes in the louse populations of the controls. In laboratory tests, the median lethal times, in hours, of 5 and 25 mg. DDT, 5 mg. γ BHC and 25 mg. malathion per sq. ft. on filter paper to lice from Maryland cattle that had never been treated with insecticide and (in brackets) lice from two of the Virginia calves that had been sprayed five times with γ BHC, as described above, were 8·4 (15·9), 4·9 (7·9), 2·7 (3·5) and 4·8 (3·2), respectively. On the 5 mg. DDT deposits, some Maryland lice were seriously affected after one hour, whereas Virginia lice were not visibly affected until seven hours had elapsed.

Webb jr. (J. E.) & Shepherd (E. L.). **Notes on control of mange mites in laboratory white mice with malathion.**—*J. econ. Ent.* **52** no. 4 p. 790, 2 refs. Menasha, Wis., 1959.

A severe outbreak of mange caused the death of about half the members of a laboratory colony of some 400 white mice in Germany in 1958. Both *Myocoptes musculinus* (Koch) and *Myobia musculi* (Schrank) were found to be present. Bedding (wood shavings) in four glass jars was treated with 0·3–6 per cent. of its weight of malathion in a 25 per cent. dust, and three infested mice were placed in each jar; complete control of the mites resulted with no harm to the mice [*cf. R.A.E.*, B **46** 171–172], which included day-old suckling young. When similar treatment with γ BHC in a 75 per cent. dust was applied, all the mice were sick or dead at the end of a week. On 1st June, all bedding for the entire mouse colony was treated with 25 per cent. malathion powder at the rate of 1 g. per jar containing 85 g. bedding. This treatment was repeated weekly when the bedding was changed, and mange had been completely cleared at the end of six weeks. Examination of several mice during the ensuing weeks revealed no mites, and treatment was discontinued in September. In November, mange reappeared, but whether as a result of residual mite infestation or reinfestation from outside is not known. Treatment was resumed at the same rate as before, with a 57 per cent. emulsion concentrate of malathion diluted at 1 : 10 with water, with the same results.

Abul-Hab (J. K.). **The seasonal occurrence of *A. superpictus* Grassi and *A. sacharovi* Favr in Suleimaniya liwa, north Iraq.**—*Bull. endemic Dis.* **2** no. 3–4 pp. 152–165, 2 graphs, 4 refs. Baghdad, 1958.

The following is largely based on the author's summary. Regular collections of adults and larvae of *Anopheles sacharovi* Favr and *A. superpictus* Grassi were made during 1953 and 1954 in three malarious villages in the Tanjiero valley, Suleimaniya, northern Iraq. House spraying with DDT in wettable-powder suspension at 2 g. DDT per sq. metre for Anopheline control was begun in two of these villages in 1954. Larvae of *A. sacharovi* were found from late May to early October and had a main peak of abundance in June and a secondary one in September. Adults were found indoors in the unsprayed villages in every month [*cf. R.A.E.*, B **46** 86], with densities reaching a peak in June and a secondary peak in October. Spraying early in April practically eliminated both peaks, but the data suggested that migratory flights into a sprayed village by this species occurred in November and December. Larvae of *A. superpictus* were found from June to October and were most plentiful in July. Adults were collected indoors only between the first week of May and the third week of November. The adult peak was attained in July, but the species remained abundant indoors until September. DDT spraying in April did not greatly modify the shape of the incidence curve, but adult density was about 80 per cent. lower after spraying.

Boshell M[anrique] (J.) & Bevier (G. A.). **Yellow fever in the lower Motagua Valley, Guatemala.**—*Amer. J. trop. Med. Hyg.* **7** no. 1 pp. 25–35, 3 figs., 15 refs. Baltimore, Md., 1958.

In view of reports of mortality in the monkeys of the lower Motagua valley, in Guatemala, mosquitos were collected in forested areas there between March and December 1956, and attempts were made to isolate viruses from them. As a result, 14 strains of yellow-fever virus were isolated from *Haemagogus mesodentatus* Komp & Kumm, three from *H. equinus* Theo. and four from *Sabethes chloropterus* (Humb.) [*R.A.E.*, B **47** 94] between March and July. All three species were definitely canopy-dwellers, and significant numbers were taken at ground level only in exceptional circumstances. Catches of *Haemagogus* were not closely correlated with rainfall as they have been further south [*cf.* **47** 93]; although there was a considerable peak in June, attributed to the spring hatching, which depends on the onset of the rains, numbers declined in the autumn in spite of heavy rains, which persisted to the end of the year. An unexpected increase in the numbers of females seen in early April, before there had been any significant rainfall, is attributed to the effect of a rise in the minimum temperature on resting populations and not to recent emergence. The coincidence in certain sectors of low mosquito catches with relatively high rates of mortality among monkeys, of which there are two species in the area (*Ateles geoffroyi vellerosus* and *Alouatta palliata*), is attributed to the attractiveness of moving bands of monkeys being greater than that of a man stationary on a branch or platform.

The last evidence of mortality in monkeys in the locality was seen in May, and the monkey population seems to have been virtually eliminated. This is in contrast with the position in the epizootic areas in Honduras, in which large numbers of monkeys survived. The difference is attributed to the presence

of *H. mesodentatus* in the Motagua valley. This is an aggressive species, which seems, moreover, to have a greater affinity with yellow-fever virus than *H. equinus* and *S. chloropterus*, the only likely vectors found in Honduras. Surveys in several directions around the Motagua valley established that, in all the forested regions to the north and west, the same association of primate and potential vector mosquitos was present as in the valley itself. Moreover, a recently described subspecies, *alticola* Galindo, Trapido & Boshell, of *H. mesodentatus* is found along the foot-hills of Alta Verapaz and across the Mexican border and may constitute another factor, the consequences of which are yet unknown. It is stated in an addendum that the virus was found in monkeys in February 1957 in the forests along the frontier with Mexico, and in May in British Honduras.

Quarterman (K. D.) & Schoof (H. F.). **The status of insecticide resistance in arthropods of public health importance in 1956.**—*Amer. J. trop. Med. Hyg.* **7** no. 1 pp. 74–83, 1 graph, 87 refs. Baltimore, Md., 1958.

Reports of resistance to insecticides in arthropods of medical importance in different parts of the world in 1956 are reviewed, with particular reference to the experimental evidence confirming them. Unsubstantiated individual reports of field resistance are excluded. Physiological resistance, confirmed by adequate experimental data, has been reported in *Pediculus humanus humanus* L., *Musca domestica* L. (including *M. d. vicina* Macq.) and species of *Anopheles* and *Culex* from most parts of the world, in *Aëdes* from North and Central America, *Blattella germanica* (L.) from North America, *Cimex lectularius* L. from North America, Europe, Asia and Hawaii and *C. hemipterus* (F.) from Asia. Confirmed cases of behaviouristic resistance are comparatively few and relate only to mosquitos, *Anopheles* spp., [*cf. R.A.E.*, B **42** 105, etc.] and *M. domestica* [*cf.* **47** 26], including *M. d. vicina*. The annual cumulative increase between 1946 and 1956 in the number of physiologically resistant species confirmed or reported is shown in a histogram, the number confirmed and (in brackets) reported having risen from 2 (2) in 1946 to 24 (37) in 1956.

Grosdanov (A.). **Berufsbedingte Ekzeme und Hautentzündungen durch Raupen der** *Plodia interpunctella*. [Occupational eczema and inflammation of the skin caused by larvae of *P. interpunctella*.]—*Berufsdermatosen* **7** pp. 30–35. Aulendorf i. Württ., 1959. (With summaries in English & French.)

Numerous cases of eczema, dermatitis and pruritus occurred over a period of 7–8 months among women employed in shelling and cleaning walnuts at an establishment in Bulgaria. The appearance of symptoms was associated with the handling of nuts infested with larvae of *Plodia interpunctella* (Hb.). This association, and the way in which the dermatoses developed, indicated that they were of an allergic nature, and this was confirmed by tests on healthy skin of persons suffering from the three conditions and of unaffected workers and others, which showed that allergens were present in alcohol extracts of the larvae and in water suspensions and acetone and alcohol extracts of their excreta.

Cotty (V. F.) & Henry (S. M.). **Glutathione metabolism in DDT resistant and susceptible house flies.**—*Contr. Boyce Thompson Inst.* **19** no. 5 pp. 393–401, 3 figs., 19 refs. Yonkers, N.Y., 1958.

The investigation described was undertaken to study the synthesis and retention of glutathione by the house-fly (*Musca domestica* L.) and to determine whether it is primarily responsible for the higher sulphydryl level that has been noted in resistant house-flies. The following is based almost entirely on the authors' summary of the results. Glutathione concentration was measured in prepupae, pupae and newly emerged adults of house-flies of susceptible and DDT-resistant strains by coupling it with ^{14}C-labelled N-ethylmaleimide. The free glutathione in both strains followed the same general pattern, no over-all difference being noted. During the period passed in the puparium, the glutathione concentration decreased for the first two days, showed a relative increase on the third and fell to a low level on the fourth day. The newly emerged adults had a higher level of glutathione than any other stage studied. Measured amounts of ^{35}S-labelled cysteine were injected into DDT-resistant and susceptible house-flies. At timed intervals, the flies were killed and the glutathione was coupled with N-ethylmaleimide and isolated chromatographically for radioassay of ^{35}S. Susceptible flies appeared to incorporate injected cysteine into glutathione and to metabolise the newly synthesised glutathione more rapidly than did resistant flies, but it was concluded that the higher sulphydryl concentration in adult resistant flies might be due to compounds other than glutathione, which were detected during the present studies but not measured quantitatively. No data on glutathione were obtained for the end of the larval period, when the enzyme that detoxifies DDT is at its highest level [*R.A.E.*, B **46** 43].

Moorefield (H. H.). **The origin of DDT resistance in the house fly.**—*Contr. Boyce Thompson Inst.* **19** no. 5 pp. 403–409, 23 refs. Yonkers, N.Y., 1958.

The following is largely based on the author's summary of experiments designed to determine whether the content of DDT-dehydrochlorinase, the enzyme that detoxifies DDT, can be increased within a single generation of the house-fly (*Musca domestica* L.). DDT-dehydrochlorinase, the occurrence of which has previously been shown to be correlated with resistance in the adult fly [*R.A.E.*, B **42** 6; **44** 100–101], was found in larvae of susceptible strains [*cf.* **39** 212]. These contained about one-third of the amount found in larvae of a resistant strain. None was found in adults of the same susceptible strains. Sublethal doses of DDT applied topically to susceptible adults failed to produce a demonstrable amount of DDT-dehydrochlorinase. Moreover, the intensity of detoxification in larvae could not be augmented by the incorporation of DDT, or non-toxic analogues of it that have an affinity for the enzyme [**44** 100], into the rearing medium. The fact that the power to metabolise DDT could not be increased without selection indicates that the development of DDT-dehydrochlorinase is not a response to the presence of DDT, and the theory that resistance in *M. domestica* is genetic in origin is substantiated.

Wells (A. L.), Stelmach (Z.), Guyer (G. E.) & Benne (E. J.). **A study of malathion for controlling flies in dairy barns and on dairy cattle.**—*Quart. Bull. Mich. agric. Exp. Sta.* **40** no. 4 pp. 786–795, 2 graphs, 6 refs. East Lansing, Mich., 1958.

The following is based largely on the authors' summary. The effectiveness of malathion for control of flies (*Musca domestica* L. and *Stomoxys calcitrans*

(L.)) in dairy barns and on dairy cattle and its effects on the cattle were studied in Michigan in 1956 and 1957. Treatment of cows with malathion, applied daily as a 0·5 or 1 per cent. spray or 4 per cent. dust or every three days as a 1 per cent. spray, at rates of 4·5, 9, 1·4 and 9 g. actual malathion per cow per treatment, respectively, did not significantly reduce the fly populations on the cows. The degree of fly control in a barn and on cows and calves was satisfactory when the 1 per cent. spray was applied as a deposit every three weeks to the barn and at the same time to the cattle. The activity of the blood cholinesterase of the cows treated daily or every three days decreased to varying extents, but started to return to normal soon after treatment ceased. When both cattle and barn were sprayed every three weeks, the cholinesterase activity of the cows decreased immediately after the first treatment, and remained low throughout the period of treatment, though not so low as when the sprays were applied more often. Malathion from all the treatments was detected in the milk in amounts that varied from 0 to 0·8 part per million with the type of treatment and interval before sampling [*cf. R.A.E.*, B **48** 124]. The milk production, body weights and general external appearance and activities of the cows were unaffected by the treatments.

Alwar (V. S.) & Seshiah (S.). **Studies on the life-history and bionomics of *Sarcophaga dux* Thomson, 1868.**—*Indian vet. J.* **35** no. 11 pp. 559–565, 11 refs. Madras, 1958.

Sarcophaga dux Thoms. is recorded from Madras as causing myiasis in wounds on a circus camel, two bullocks and a cow, and an account is given of the bionomics of the species based on material bred from these sources and from flies caught in nature near meat stalls or a stream polluted with human excrement. Stale meat was used as a breeding medium. Though flies could be kept alive for up to 15 days with glucose, a protein feed was essential for larviposition. Flies generally deposited 29–35 larvae at a time, and the shortest interval between emergence of the female and larviposition was 7 days. The larval and pupal periods lasted 4–8 and 7–11 days, respectively, at 74–94°F.

Harrison (I. R.) & Marshall (P. G.). **The depletion of insecticides in sheep dipping baths.**—*J. Sci. Fd Agric.* **10** no. 10 pp. 568–576, 10 graphs, 2 refs. London, 1959.

The following is virtually the authors' summary. The depletion of aldrin, dieldrin and γ BHC from sheep-dipping baths under field conditions was examined. The methods of sampling and infra-red analysis of the insecticide are fully described. The factors affecting the depletion rate of sheep dips are discussed, and the results show that where the initial concentration is high, rapid depletion occurs. A more constant insecticide level may be achieved by lowering the initial concentration and increasing the amount of chemical added at topping up. Further work is in progress.

Tarshis (I. B.). **Sorptive dusts on cockroaches.**—*Calif. Agric.* **13** no. 2 pp. 3–5, 4 figs. Berkeley, Cal., 1959.

Sorptive dusts can kill certain kinds of insects by causing them to die of desiccation through their abrasive effect on the cuticle or their adsorption

of its lipid elements [*cf. R.A.E.*, A **47** 379]. As resistance to chlorinated-hydrocarbon and other insecticides has become widespread in *Blattella germanica* (L.) in the United States [B **47** 152, etc.] and has been reported in other species of cockroaches, extensive experiments on the effect of sorptive dusts on them were undertaken in 1958, and two of the 78 compounds tried, a silica aerogel and a silica gel called, respectively, SG 67 and SG 77, were outstanding, though the latter acted more slowly. When cockroaches were allowed to crawl over SG 67 in large jars for one minute, males and (in brackets) females of *B. germanica*, *Supella supellectilium* (Serv.), *Blatta orientalis* L. and *Periplaneta americana* (L.) died in 45 (95), 160 (190), 180 (240) and 270 (450) minutes, respectively, and the percentages of weight lost at death were 20 (20), 35 (25), 19 (17) and 21 (28).

Both SG 67 and SG 77, which is about 2·5 times heavier, leave a good film on wood, glass, etc. Adults of *Blattella germanica* that crawled over a wet suspension of SG 67 died as quickly as those that crawled over the dry deposit. When the material had been soaked and allowed to dry, its action was somewhat slower. The silica gels were equally effective in killing a wide range of pests, including bedbugs [*Cimex lectularius* L.], fleas, ticks, mites, lice and house-flies [*Musca domestica* L.], but their use against many of these would probably not be practicable. They are particularly suitable for use against household pests as they are not toxic to man.

In April, a house in southern California infested with *Blatta orientalis* was treated with SG 77, the dust being applied to various parts of the kitchen and service porch. Many dead cockroaches were seen after three days, and the house, which was under observation for nine months, was reported to be completely free from cockroaches. Excellent control of cockroaches of various species was subsequently obtained in 60 other establishments in southern California. A visible film should be applied in any places frequented by cockroaches and left until no more newly hatched nymphs are seen; in concealed places, it should be left permanently.

Grayson (J. M.) & Jarvis jr. (F. E.). **Residual effectiveness of certain insecticides in German cockroach control.**—*Soap & chem. Spec.* **34** no. 3 pp. 91–92, 133, 2 refs. New York, N.Y., 1958.

The effectiveness of 13 formulations of seven insecticides against females of the German cockroach [*Blattella germanica* (L.)] of a chlordane-resistant and a normal strain was determined by exposing the cockroaches to deposits of the compounds from emulsions or solutions in refined kerosene on tempered masonite panels [*cf. R.A.E.*, B **46** 168]. Deposits of malathion from a 2 per cent. emulsion were also tested on panels of galvanised sheet metal and of diazinon from a 0·5 per cent. emulsion on panels of six different materials commonly found inside buildings. The panels were dipped in the diluted materials and the deposits allowed to age for 2, 7, 15, 30 and 60 days, after which the cockroaches were exposed to them for one day or three days. Dicapthon (Am.Cyanamid 4124) was the most effective; deposits from 0·5, 1 or 2 per cent. emulsions gave complete kill in all tests of cockroaches of both strains exposed for three days, irrespective of the period of aging, and those from the two higher concentrations, except after aging for 60 days, gave 88 per cent. kill or more in one day. Deposits of diazinon from a 0·25 or 0·5 per cent. emulsion or a 0·5 per cent. oil solution gave 88 per cent. kill or more of both strains after one day's exposure to deposits on masonite aged for 30 days or less, but exposure for three days was needed to give similar results with deposits 60 days old. Korlan [O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate] gave about 90 per cent. kill or more of both strains exposed for one day to deposits, from a 1 per cent.

emulsion, aged for 15 days, and for three days to deposits aged for 60 days. Deposits of malathion from a 2 per cent. emulsion or oil solution gave about 90 per cent. kill or over of both strains in all tests with three days' exposure and those from a 1 per cent. emulsion did so for 30 days. The deposits from the oil solutions were equally satisfactory for seven days with one day's exposure, but those from the emulsions were never reliable with the shorter exposure on masonite, though they gave over 90 per cent. kill for 15 days on sheet metal. The deposits from oil solutions of chlordane at 2 per cent. and dieldrin at 0·5 per cent. gave very low kills of resistant cockroaches in all exposures, and only moderate kills of non-resistant ones, and, in the one-day exposures, those from an emulsion of 2·5 per cent. Dilan [a 1:2 mixture of Prolan and Bulan] were never satisfactory. With exposure for three days, ten deposits from a 0·5 per cent. diazinon emulsion gave over 90 per cent. mortality of both strains after aging for 60 days on wall board, 30 days on painted wood or plastic tile, seven days on inlaid linoleum and two days on Congoleum flooring. Deposits on glass never gave appreciable kills.

Barsa (M. C.) & Ludwig (D.). **Effects of DDT on the respiratory enzymes of the mealworm,** *Tenebrio molitor* **Linnaeus, and of the house fly,** *Musca domestica* **Linnaeus.**—*Ann. ent. Soc. Amer.* **52** no. 2 pp. 179–182, 1 graph, 11 refs. Washington, D.C., 1959.

Experiments were undertaken to determine the *in vitro* effects of DDT on the activities of respiratory enzymes of larvae of *Tenebrio molitor* L. and *Musca domestica* L., and the following is virtually the authors' abstract of the findings. The amount of inhibition caused by 10^{-3} M DDT increased with a decrease in enzyme concentration, both with cytochrome oxidase and succinic dehydrogenase, in the homogenates; hence, DDT appears to be irreversible in its action. It is an inhibitor of cytochrome oxidase [*cf. R.A.E.*, B **45** 176, etc.] and succinic dehydrogenase, but not of alcohol, glucose, lactic, alpha-glycerophosphate or isocitric dehydrogenase or of the malic enzyme. It inhibits only the cyanide-sensitive respiration. The inhibition of the cytochrome-oxidase activity of a 0·3 per cent. homogenate of the larvae of *M. domestica* was 65 per cent. This inhibition remained constant over a two-hour period.

Stahler (N.). **Some changes in the biological characteristics of colonized** *Anopheles quadrimaculatus* **Say.**—*Ann. ent. Soc. Amer.* **52** no. 2 pp. 214–219, 2 graphs, 7 refs. Washington, D.C., 1959.

The following is substantially the author's abstract. Selective changes are reported in a colony of *Anopheles quadrimaculatus* Say, maintained for seven years under constant laboratory conditions, either in the natural day–night cycle or in a daily cycle of 12 hours artificial light and 12 hours darkness. The percentage of females inseminated was significantly higher during 1953–55 than in 1950–52, when there was a significant abeyance in sexual activity during some mid-winter months, even in those groups cohabiting in a constant daily cycle of illumination. Since such diapause disappeared in the subsequent years, it was assumed to have been an inherent character in the epigamic behaviour of this strain but to have been eliminated by selection within the colony. A concomitant increase in male survival within the experimental groups was probably a major factor in this. No such changes were noted in the proportions of female survival.

Hoogstraal (H.) & Kaiser (M. N.). **Observations on Egyptian *Hyalomma* ticks (Ixodoidea, Ixodidae). 5. Biological notes and differences in identity of *H. anatolicum* and its subspecies *anatolicum* Koch and *excavatum* Koch among Russian and other workers. Identity of *H. lusitanicum* Koch.**—*Ann. ent. Soc. Amer.* **52** no. 3 pp. 243–261, 27 figs., 28 refs. Washington, D.C., 1959.

The following is based on part of the authors' abstract. Exhaustive study of very considerable material confirms the opinions of the Pomerantsev school that *Hyalomma anatolicum* Koch and *H. excavatum* Koch are taxonomically valid subspecies (of *anatolicum*), that the subspecies *anatolicum* is that which non-Soviet workers have been referring to as *H. excavatum*, *sensu* Delpy, and that the subspecies *excavatum* is that which non-Soviet workers have been calling *anatolicum*, *sensu* Delpy. The immature stages of the subspecies *excavatum*, which differ morphologically from those of *anatolicum*, feed on rodents, rabbits and hares, whereas those of *anatolicum* generally feed on larger domestic animals. The former subspecies breeds actively during the winter months (in North Africa, at least), while the latter usually undergoes a winter diapause. These forms, which rank high among the world's economically most important ticks, range from southern Europe and northern Africa through the Near and Middle East to the Indian subcontinent. Narrowly elongate samples from populations at the eastern end of this range suggest the presence of yet another subspecies in this area (rearing experiments undertaken to determine their status will require a year or more for completion). *H. a. anatolicum* is usually more numerous than *H. a. excavatum* and is more uniformly distributed, while *excavatum* is absent in certain ecological zones where *anatolicum* is present. Intergradation is nil in most areas, but ranges from 2 to less than 20 per cent. among certain Mediterranean littoral populations of Egypt and Libya. Movements of domestic animals appear in some areas partially to break down the ecological isolation of the two forms. *H. lusitanicum* Koch, synonymised with *H. anatolicum* by many workers, is found to be a valid species occurring in south-western Europe, the Canary Islands and Morocco. Morphological and biological characters of the recently recognised *H. franchinii* Rondelli are compared with those of the *anatolicum* complex, for which keys to males and females are provided.

Al-Azawi (A.) & Chew (R. M.). **Notes on the ecology of the dark rice field mosquito, *Psorophora confinnis*, in Coachella Valley, California (Diptera: Culicidae).**—*Ann. ent. Soc. Amer.* **52** no. 4 pp. 345–351, 2 graphs, 8 refs. Washington, D.C., 1959.

The following is based on the authors' abstract. Larvae of *Psorophora confinnis* (Lynch Arrib.) occur in a variety of temporary waters in the Coachella Valley of southern California, but were found on many date ranches only in the irrigated lanes between the palms. The density of the larvae and pupae was higher in grassy areas and under pruned date fronds than in areas bare of cover, and the larvae concentrated near cow droppings. Size of fourth-instar larvae tends to vary with larval density. Fourth-instar larvae and pupae were once observed completing their development in muddy areas where irrigation water had disappeared from the surface. In the laboratory they did so on moist filter paper, but third-instar larvae developed no further. Larvae and pupae are attracted to light at night. Water persists in the date lanes for an average of 5·1 days after each fortnightly flooding; the adequate development of *P. confinnis* can be completed within this time only at water temperatures of 26°C. [78·8°F.] or higher. Hence,

adults are numerous only from mid-June to the end of September. The scarcity or absence of adults on irrigated ranches lacking livestock suggests that cattle are the necessary principal host. Females usually cannot pierce human skin until four hours after emergence; to survive, they must feed within 24 hours. Adults are nocturnal and both sexes are attracted to lights. Trap-light captures reach a peak 2–3 hours after sunset. During the day, adults cling to grasses, especially over moist or soggy soil, and fly only a few metres when disturbed, usually at a height of 1 m. or less. Males disappear rather abruptly, but the female population declines slowly as the soil dries. Tests showed that moist soil with grass cover was strongly preferred for oviposition, and moist soil without cover, water and dry soil were progressively less attractive. Toxaphene, at 0·75 U.S. gal. in 50 U.S. gal. water per five acres, killed second- and third-instar larvae, but was ineffective against older aquatic stages. Control might be achieved by changing the irrigation régime so that water would persist in the lanes for only 3–4 days after each flooding.

Insecticide resistance in arthropods of medical and veterinary importance.—*Misc. Publ. ent. Soc. Amer.* **1** no. 1, 32 pp., 3 graphs, refs. Washington, D.C., 1959.

The four papers noticed below, all from the authors' abstracts, were read at a symposium held in Utah in December 1958.

Schoof (H. F.). **Resistance in arthropods of medical and veterinary importance—1946–58** (pp. 3–11, 1 graph, 45 refs.). Resistance to insecticides among arthropods of public-health importance has shown a steady increase since the initial report of resistant *Musca domestica* L. and *Culex pipiens molestus* Forsk. in 1947. In 1946–58, physiological resistance to one or more insecticides was reported in 46 species and confirmed in 30 of them [*cf. R.A.E.*, B **48** 204], including 20 species of mosquitos (nine malaria vectors, two transmitters of encephalitis, one transmitter of yellow fever, and one vector of filariasis). In 1958, dieldrin resistance was reported in *Anopheles albimanus* Wied. in Salvador, Guatemala and Nicaragua, in *A. pseudopunctipennis* Theo. in Mexico and in *A. aquasalis* Curry in Trinidad. In certain parts of Salvador and Nicaragua, *A. albimanus* is also resistant to DDT. Except for resistance in *Chrysomyia putoria* (Wied.) in the Belgian Congo, and in *Lucilia* (*Phaenicia*) *cuprina* (Wied.) in Australia [*cf.* **48** 134], blowfly species remain susceptible to chlorinated-hydrocarbon insecticides. Other species in which physiological resistance has been confirmed [*cf.* **48** 204] include *Glyptotendipes paripes* (Edw.) and *Culicoides furens* (Poey). Behaviouristic resistance to DDT is evident in *A. albimanus* in Panama [*cf.* **42** 105], and *M. domestica* has displayed similar resistance to malathion bait in a few localities in the United States [**47** 26]. Resistance to both organophosphorus and chlorinated-hydrocarbon insecticides has been demonstrated in *M. domestica* [**47** 26], *Chrysomyia putoria*, *G. paripes* [**46** 157], *Culex tarsalis* Coq. [**47** 198] and *Aëdes nigromaculis* (Ludl.). Despite the increase in the magnitude of the resistance problem, many species remain susceptible to DDT and other chlorinated hydrocarbons even though under repeated exposure to these toxicants for periods of 5–10 years.

March (R. B.). **Resistance to organophosphorus insecticides** (pp. 13–19, 15 refs.). Strains of *Musca domestica* L. resistant to organophosphorus insecticides are significantly different in a number of ways from those resistant only to chlorinated-hydrocarbon insecticides [**47** 72]. Chlorinated-hydrocarbon resistance is characterised by the development of uniformly high levels of resistance, by limitations due to the saturation of absorption

systems and by marked cross tolerances, especially to closely related compounds, but not to organophosphorus insecticides. Further, it is relatively stable or decreases only slowly after removal of selection pressure. Organophosphorus resistance is characterised by biochemically-limited resistance levels peculiar to each particular insecticide, beyond which it has not been possible to increase resistance by further selection pressure. It is more specific, and cross tolerances to other organophosphorus insecticides are less marked. However, strains of *M. domestica* exposed to routine selection by organophosphorus insecticides develop high levels of resistance to chlorinated-hydrocarbon insecticides even though resistance to the selecting organophosphorus compound may be minimal. Finally, resistance to the organophosphorus insecticides is relatively unstable and decreases, at first at a rapid rate, on removal of selection pressure. Studies on the mechanisms of resistance to organophosphorus insecticides have shown that resistance is not primarily related to higher levels of cholinesterase activity, to cholinesterase less susceptible to inhibition, or to the efficiency of toxifying systems. Rather it is related to detoxication mechanisms and the rate of destruction of the active compound in relation to the rate of accumulation in critical concentration at sites of action.

Brown (A. W. A.). **Inheritance of insecticide resistance and tolerance** (pp. 20–26, 2 graphs, 62 refs.). In several laboratory and field strains of insects, resistance to DDT or dieldrin has been deduced to be due to a single gene allele. In other strains, resistance has been non-specific and considered to be due to vigour tolerance. The dosage-mortality curves of successive generations have been shown to be of use in determining whether resistance is unifactorial or polygenic in origin. Examples of these two types are drawn from *Drosophila melanogaster* Mg., *Musca domestica* L. and several species of *Anopheles*. The relation of DDT-dehydrochlorinase to the genetic origin of DDT resistance and the significance of inducing DDT resistance and tolerance by means not involving DDT are discussed. The existence of multiple modifier genes, which may be partially congruent with vigour-tolerance genes, is indicated by the rapid redevelopment of resistance by reverted strains. Gene alleles for resistance may be pleiotropic and may confer extra susceptibility to certain "negatively-correlated" compounds. The relation of visible chromosome inversions to resistance genes is discussed. Full understanding of the genetic nature of the various resistances depends on a knowledge of the biochemical mechanisms involved, and the above considerations will aid in foretelling the consequences of insecticide selection pressure on an arthropod species.

Knutson (H.). **Changes in reproductive potential in house flies in response to dieldrin** (pp. 27–32, 33 refs.). Biological changes following the use of dieldrin are summarised. Also included are the results of a field study wherein a previously unsprayed ranch in Kansas with a known initially insecticide-susceptible population of *Musca domestica* L. was sprayed five times over a three-year period [*cf.* **48** 189]. Resistance generally increased over this period as well as the following year, except for a temporary decrease following overwinterings. Reproductive potential was generally unchanged in the first two years, decreased in the third, but increased above the pre-spray potential in the fourth year. Significant differences in percentage survival occurred yearly within each life-history stage, during those years in which evaluations were made. Two extensively studied insecticide-susceptible laboratory populations had several times the reproductive potential of three field populations. These studies suggest that results obtained while investigating reproductive potential and other characteristics of one population are not necessarily applicable to another. Differences in success of chemical control measures against larvae and adults may be expected

because of corresponding differences in survival rates of the various life-history stages. Whether biological changes accompanying insecticide resistance can be predicted in the laboratory in advance of field control measures is questionable because of differences between laboratory and field environments, the possible use of inadequate population samples in establishing laboratory cultures, difficulty in reproducing field conditions of exposure to insecticides in the laboratory and the time involved in evaluating results. Biological changes resulting from repeated treatments generally are more apparent when the control programme is well advanced and particularly when control results are adverse. These changes are generally difficult to evaluate if based on field data alone.

Assessment of susceptibility to insecticides in Anopheline mosquitos.—*Bull. World Hlth Org.* **16** no. 4 pp. 874–890, 7 refs. Geneva, 1957.

A summary is given in tabular form of the results of tests carried out (with few exceptions, in the field) by workers to whom test outfits for determining the susceptibility of Anophelines to insecticides had been issued by the Malaria Section of the World Health Organization. The method of Busvine & Nash [*R.A.E.*, B **41** 156] was used, the insecticides under test were DDT, dieldrin and γ BHC, and LC50's were determined. No distinction is made between susceptible and resistant strains because of the difficulty of distinguishing between them. Strains from treated areas often had an LC50 higher than that of strains from unsprayed areas, but in most cases the small increase could represent no more than vigour tolerance [*cf.* **47** 72]. There did not seem to be much variation in the susceptibility of strains from untreated areas.

Oppenoorth (F. J.). **Resistance patterns to various organophosphorus insecticides in some strains of houseflies.**—*Ent. exp. appl.* **2** no. 3 pp. 216–223, 1 graph, 11 refs. Amsterdam, 1959. (With a summary in German.)

The following is based on the author's summary. The susceptibility of one susceptible and six resistant strains of house-flies [*Musca domestica* L.] to 13 organophosphorus compounds was measured by a contact method. Five of the strains had been selected, both in the field and in the laboratory, with diazinon, parathion or malathion. One had been strongly selected in the laboratory with γ BHC. This strain had only a low level of resistance to organophosphates, but the other resistant ones showed higher levels, each with its own characteristic pattern [*cf. R.A.E.*, B **48** 161]. This indicates the existence of a relatively large number of resistance mechanisms. As resistance to phosphorothioates was of the same order of magnitude as that to their oxygen analogues, it follows that the resistance mechanism is not a slower conversion of the phosphorothioates into the phosphates. Resistance to a number of dimethyl compounds was low, with little difference between resistant strains. This resistance is probably brought about by less specific factors. The genetical basis of the low aliesterase content [*cf.* **48** 161] of the phosphate-resistant strains is discussed.

Moorefield (H. H.). **Synergism of the carbamate insecticides.**—*Contr. Boyce Thompson Inst.* **19** no. 6 pp. 501–507, 1 graph, 12 refs. Yonkers, N.Y., 1958.

When two aromatic carbamates, 3-tert.-butylphenyl N-methylcarbamate and Sevin, and two heterocyclic carbamates, Pyrolan and Isolan, were applied

topically to adult females of *Musca domestica* L., alone and with four methylenedioxyphenyl synergists, piperonyl butoxide, sesamex (Sesoxane), sulfoxide, propyl isome and a commercial preparation of sesame-oil extractives, in insecticide : synergist ratios varying from 1 : 1 to 1 : 20, the additions increased toxicity, especially over the range 1 : 5–1 : 10. The first two carbamates, which gave kills of only about 70–80 per cent. at doses of 10–40 μg. per fly, caused complete or almost complete mortality in 18 hours at 1 μg. or less when combined 1 : 5 with piperonyl butoxide, and Sevin at 0·2 μg. and piperonyl butoxide at 2 μg., though each alone completely non-toxic, together gave complete kill. Isolan and Pyrolan alone gave almost complete mortality at doses of less than 10 μg. per fly, but were about ten times as effective with the addition of piperonyl butoxide. Sesamex appeared to be as effective a synergist as piperonyl butoxide, and sulfoxide and propyl isome were almost as effective, but the sesame-oil extractives were much less so.

The effect of piperonyl butoxide on Sevin was also beneficial in baits of sugar solution, supplied to house-flies for 24 hours, in which doses of 5 and 10 mg. insecticide per 100 ml. gave 3 and 28 per cent. mortality, respectively, alone and 60 and 100 per cent. with five times as much synergist, and in topical applications to adult males of *Blattella germanica* (L.), in which 5 and 10 μg. Sevin per insect gave 0 and 5 per cent. mortality alone and 90 and 100 per cent. with ten times as much synergist.

It is concluded that synergism would provide a means of practical control of *M. domestica* with Sevin and 3-tert.-butylphenyl N-methylcarbamate, which are otherwise unsatisfactory against it.

Moorefield (H. H.) & Tefft (E. R.). **Evaluation of 2-(3,5-dichloro-2-biphenylyloxy)triethylamine as an insecticide adjuvant.**—*Contr. Boyce Thompson Inst.* **20** (1959) no. 4 pp. 293–298, 20 refs. Yonkers, N.Y., 1960.

The following is based on the authors' summary. In the tests described, 2-(3,5-dichloro-2-diphenylyloxy)triethylamine, which extends the activity of a diverse series of unrelated drugs through inhibition of metabolic transformation, but is itself non-toxic to insects, effectively synergised 3-tert.-butylphenyl N-methylcarbamate, Sevin, Pyrolan and Isolan, but not pyrethrins, allethrin, cyclethrin, DDT, diazinon or malathion in topical applications to adults of *Musca domestica* L., and did not inhibit DDT-dehydrochlorinase, the detoxication enzyme from DDT-resistant flies, *in vitro*.

The results indicate that synergism of the pyrethrins and the carbamates is not a correlative phenomenon and that, although the same compounds have been shown to increase the action of both classes of toxicants, specific carbamate synergists exist.

McCollister (D. D.), Oyen (F.) & Rowe (V. K.). **Toxicological studies of O,O-dimethyl-O-(2,4,5-trichlorophenyl) phosphorothioate (ronnel) in laboratory animals.**—*J. agric. Fd Chem.* **7** no. 10 pp. 689–693, 23 refs. Easton, Pa., 1959.

Ronnel (O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate) is used against several insects of veterinary or hygienic importance. Studies were undertaken with laboratory animals to ascertain the precautions to be adopted in handling it and to evaluate its safety in use, and the following is based on the authors' summary of the results.

Ronnel was low in acute toxicity when administered orally or absorbed through the skin, had only slight irritating effects on the skin or eyes and was not a skin sensitiser. No morphological changes were observed in long-term feeding studies in which rats received 15 mg. per kg. body weight per day and dogs 10 or 25 mg. per kg. per day. Cholinesterase levels of the plasma were depressed more than those of the red blood cells or the brain, although substantial amounts of enzyme remained even after ingestion of large dosages of ronnel. No unusual precautions seem necessary in handling, and it is concluded that the product is safe for use as recommended.

Carpenter (C. P.), Weil (C. S.), Palm (P. E.), Woodside (M. D.) & Smyth jr. (H. F.). **The toxicology of butoxypolypropylene glycol 800 (Crag Fly Repellent).**—*J. agric. Fd Chem.* **7** no. 11 pp. 763–769, 2 graphs, 8 refs. Easton, Pa., 1959. **Correction.**—*Op. cit.* **8** no. 1 p. 42; no. 2 p. 91. 1960.

Butoxy polypropylene glycol 800, sold as Crag Fly Repellent, has been found effective as a fly repellent for use on dairy cattle [*R.A.E.*, B **39** 137]. Experiments on its safety when used for this purpose were carried out on laboratory animals, and the following is based on the authors' summary of the results. Single-dose studies showed that the compound had only slight oral and skin penetration toxicity for rodents and did not increase toxicity when fed orally to rats with nine available insecticides. Subcutaneous and intraperitoneal injection, compared with direct intravenous injection, demonstrated that the compound passes tissue barriers poorly and offers little or no hazard by the usual portals of entry to the body. It is not stored in the bodies of animals, and 50 per cent. or more of a single dose may be found in the faeces unchanged. Rats tolerated 640 parts per million in the daily diet in chronic feeding for two years, while dogs tolerated 890 p.p.m. for one year.

Beklemishchev (V. N.) & Shipitsina (N. K.). Ed. **Les phénomènes saisonniers de la vie des anophèles de l'URSS.** [*In Russian.*]—8 × 5¾ in., 527 pp., 107 figs., 1 fldg. chart, 6½ pp. refs. Moscow, Inst. Parasit. méd., Minist. Santé publ. URSS, 1957.

This book consists of an introduction and 34 papers by different authors on the phenology of several species of *Anopheles*, notably members of the complex of *A. maculipennis* Mg., in various localities and areas throughout the Soviet Union. The latter are treated as subspecies of *A. maculipennis*. They include *A. m. maculipennis*, *A. m. messeae* Flni., *A. sacharovi* Favr and *A. labranchiae atroparvus* van Thiel.

Rivola (E.) & Holstein (M. H.). **Note sur une variété d'*Anopheles nili* Theo.**—*Bull. Soc. Path. exot.* **50** no. 3 pp. 382–387, 2 figs., 10 refs. Paris, 1957.

Anopheles nili var. *somalicus*, n., is described from larvae and pupae, and from adults derived from them, collected in the vegetation on the edges of the Uebi Scebeli river, Somalia; unlike the typical form [*cf. R.A.E.*, B **34** 7; **42** 62; **46** 62, 84], it appears to be completely exophilous and zoophilous.

Colless (D. H.). **Recognition of individual nulliparous and parous mosquitoes.**—*Trans. R. Soc. trop. Med. Hyg.* **52** no. 2 p. 187, 1 ref. London, 1958.

A brief account is given of a method that has been found useful in Singapore for recognising individual nulliparous and parous Culicine mosquitos. It is based on the observation that corpora lutea [*R.A.E.*, B **47** 190] can be found in the ovaries of parous females of all the species so far examined (*Culex pipiens fatigans* Wied., *C. tritaeniorhynchus* Giles, *C. gelidus* Theo. and *Aëdes albopictus* (Skuse)). The ovaries are dissected, well flattened by withdrawal of fluid from under the cover slip and examined by pale-blue light at a magnification of about 200. If they are from a parous mosquito, corpora lutea are then seen as clumps of small pigmented granules lying in the intra-ovarian space, their colour and, to some extent, their size and shape varying with the species. The number in individual ovaries varies considerably, but a few can always be seen. The principal advantage of the technique is its speed. Cords, rather similar to those described in Anophelines [*loc. cit.*], are attached to the oocytes in both parous and nulliparous females. In the latter, each cord is a chain of some 5–10 bead-like cells, but in the former they terminate in one or more dilatations, which sometimes contain the pigmented granules referred to above, and the number of such dilatations corresponds with the number of previous ovipositions.

Bertram (D. S.), McGregor (I. A.) & McFadzean (J. A.). **Mosquitoes of the Colony and Protectorate of the Gambia.**—*Trans. R. Soc. trop. Med. Hyg.* **52** no. 2 pp. 135–151, 3 figs., 37 refs. London. 1958. **Some Diptera, other than mosquitoes, from the Colony and Protectorate of the Gambia.**—*T. c.* no. 3 pp. 217–222, 14 refs.

The following paragraphs are based almost entirely on the authors' summaries of these two papers, respectively.

A mosquito survey of the Gambia was carried out in 1952–54, mainly in the rainy season (July to September), and was primarily concerned with conditions in African villages near the *Rhizophora-Avicennia* mangrove swamps of the brackish tidal waters of the river Gambia and its creeks [*cf. R.A.E.*, B **34** 5–6], but some attention was also given to a semi-urban European residential area on the coast. More than 50 species and varieties of mosquitos were taken, of which almost half, including five Anophelines, are recorded from the Gambia for the first time. The adults included several females, taken biting man in shade in the late afternoon, of a species close to *Aëdes palpalis* (Newst.) that was to be described as new. The mosquitos predominantly associated with man and human dwellings were *Anopheles gambiae* Giles (typical form) and *A. gambiae melas* Theo.; the first bred in small collections of fresh water. Besides *Avicennia* mangrove, growths of sea-purslane (*Sesuvium portulacastrum*) on the extensive sand flats of the brackish-water swamps of the river and its creeks were important indicators of the breeding places of *melas*. Members of the *gambiae-melas* complex were prominent among mosquitos taking part in massive invasions of imperfectly screened houses near the beginning of the rains and periodically during them. Sporozoites were found in the glands of females of the complex, and it is concluded that these mosquitos are the important, and possibly the only, vectors of malaria in the lower Gambia. Infective filarial larvae were also found in them, and as *Culex pipiens fatigans* Wied. was virtually absent, only two females being taken near the coast, and *Anopheles funestus* Giles was very infrequent, it is assumed that *A. g. gambiae* and *A. g. melas* are the important, if not the sole, vectors, of

Wuchereria bancrofti in lower Gambia. Nevertheless, there is some doubt as to whether all the infective filarial larvae in the mosquitos are *W. bancrofti*. Domestic cattle are staked outdoors at night near the village to which they belong, and many of them have been shown to be infected with microfilariae of *Setaria cervi*. The vector of this infection is not known, but the literature suggests the possibility of mosquito transmission. Several species of mosquitos that feed on man, including *A. g. gambiae* and *A. g. melas*, feed also on domestic cattle, and it is possible that infective filarial larvae in females of these forms are *S. cervi*. Moreover, *Dirofilaria aethiops*, a filarial parasite experimentally transmissible by both Culicines and Anophelines, is known from a monkey from the Gambia and from *Cercopithecus aethiops johnstoni* in East Africa. The related common West African green monkey (*C. a. sabaeus*) is common in the Gambia, and mosquitos of the *gambiae-melas* complex were the most numerous of several species taken in a brief collecting period after dark on a tree platform in bush known to be frequented by monkeys.

Records are given of 45 species and varieties of Diptera, other than mosquitos, taken in the Gambia in the rainy season of 1952. They are arranged according to the species observed in European houses by day and by night, in African villages indoors and outdoors, and elsewhere by day and in certain special circumstances. The species observed biting man were *Culicoides milnei* Aust. (*austeni* C., I. & M.), *C. nigeriae* I. & M., *Lasiohelea lefanui* (Carter), *Tabanus taeniola* P. de B., *T. biguttatus* Wied., *Ancala latipes* (Macq.), *Glossina palpalis* (R.-D.) and *G. morsitans* Westw.

Weinbren (M. P.), Haddow (A. J.) & Williams (M. C.). **The occurrence of Chikungunya virus in Uganda.**—*Trans. R. Soc. trop. Med. Hyg.* **52** no. 3 pp. 253–262, 5 refs. London, 1958.

Chikungunya virus is the name given to an agent first isolated in the Newala district of Tanganyika during an epidemic of dengue-like illness in 1952–53 [*cf. R.A.E.*, B **43** 206–207]. It was found to be pathogenic for suckling mice but not for the adults. Details are given in the present paper of the isolation and identification in 1956 of a strain of the same virus from one of 60 pools, totalling 1,347 females, of *Aëdes africanus* (Theo.) caught on the edge of Zika Forest, near Entebbe, Uganda, and of another from serum from an African mosquito catcher, who had reported sick, also from the Entebbe area. The positive mosquito pool comprised 74 females, taken on a platform at a height of 65 ft. and 4 taken at ground level, all in June. The strain from it was isolated in both mice and a rhesus monkey [*Macaca mulatta*] and that from human serum in mice only. The virus was pathogenic for the monkey. A second case of illness, in another African mosquito catcher from the same area, was shown, by tests with two samples of the man's serum, to have been caused by the Chikungunya virus.

Robertson (D. H. H.) & Baker (J. R.). **Human trypanosomiasis in south-east Uganda. I. A study of the epidemiology and present virulence of the disease.**—*Trans. R. Soc. trop. Med. Hyg.* **52** no. 4 pp. 337–348, 4 figs., 22 refs. London, 1958.

The following is based on the authors' summary and conclusions. The virulence of the strain of trypanosome now causing sleeping sickness in south-eastern Uganda is described, and it is shown that *Trypanosoma gambiense* [*cf. R.A.E.*, B **17** 37] has been completely replaced by *T. rhodesiense*, possibly since the epidemic of 1940 [**33** 101]. As *Glossina pallidipes* Aust. tends to bite below the knee [*cf.* **31** 89], whereas *G. palpalis*

(R.-D.) prefers the body, head and neck, the fact that trypanosome chancres seen in 1956–57 were nearly all on the leg below the knee provides evidence that *G. pallidipes* is the major vector of *T. rhodesiense* in the area. Moreover, B. D. Rennison reported failure to isolate *T. rhodesiense* from 3,706 adults of *G. palpalis* caught at or near Lugala. Although *T. rhodesiense* has replaced *T. gambiense* and the major vector is *G. pallidipes*, the disease still remains concentrated in the same foci and affects the same class of people (fishermen and fish-traders) as did *T. gambiense* before 1940 [*cf.* **17** 38]. During and immediately after the rains in May and June 1957, the incidence increased in the villages on the inland fringe of the *pallidipes* fly-belt, and this was associated with a seasonal extension of the range of the fly. The focal distribution of the disease suggests that game is not a major reservoir in this area and that man-fly-man passage is continuous. It is thought that asymptomatic cases and those relapsing after incorrect drug treatment constitute the main reservoir. One case of each of these types is described. No evidence was found that the virulence of a strain of *T. rhodesiense* was reduced by remaining a long time (2½ years) in a man. As Lugala and Sugulu (Matoro) are main foci of *T. rhodesiense*, and are visited constantly by fishermen and fish-traders, they constitute an important risk to neighbouring territories. Infection with *T. rhodesiense* has occurred in Bunyala, Kenya, and it is probable that further cases may occur as the population there lives in intimate contact with *G. pallidipes*. The eastern shore of Lake Victoria is mainly at risk, but more remote spread is liable to occur as the fishermen and fish-traders of Bunyala travel widely in their dhows.

Boorman (J. P. T.). **Transmission of Uganda S virus by** *Aedes* (*Stegomyia*) *aegypti* **Linn.**—*Trans. R. Soc. trop. Med. Hyg.* **52** no. 4 pp. 383–388, 3 graphs, 12 refs. London, 1958.

In recent serological studies carried out on the African population of the village of Ilobi, 30 miles from Lagos, Nigeria, 91 of 207 sera collected gave a positive result in mouse-protection tests with Uganda S virus. This suggested that human infection with this virus was not uncommon. As the virus was originally isolated from species of *Aëdes* [*R.A.E.*, B **42** 164], it seemed possible that members of this genus might be responsible for transmission to man, and the ability of a local strain of *A. aegypti* (L.), the commonest species of *Aëdes* at Ilobi, to become infected and to transmit infection by bite was investigated. It was found that the mosquitos could acquire infection by feeding on a mixture of blood and virus through a mouse-skin membrane [**46** 97], that the percentage of individuals becoming infected increased in proportion to the amount of virus ingested (being 50 when the dose was about $10^{4\cdot4}$ mouse LD50's and exceeding 90 when it was more than $10^{6\cdot5}$), that virus was retained within the body of the mosquito for up to 79 days, and that transmission to mice four days old by bite was effected after a short incubation period, the percentage of individuals able to transmit increasing in proportion to incubation time for up to about 40 days. It is concluded that in certain circumstances *A. aegypti* may be an efficient vector of the virus.

Lewis (D. J.). **The recognition of nulliparous and parous** *Anopheles gambiae* **by examining the ovarioles.**—*Trans. R. Soc. trop. Med. Hyg.* **52** no 5 pp. 456–461, 40 figs., 19 refs. London, 1958.

A brief description is given of a technique whereby the ovaries of females of *Anopheles gambiae* Giles that had been killed by drowning in normal

saline containing detergent were separated in saline alone, and individual ovaries were placed in a drop of saline and detergent and some of the ovarioles with or without sheaths were isolated. The detergent served to swell the ovaries and so facilitate dissection and to burst many cells of the ovarioles so that the tunica propria became clearly visible and indicated the shape of follicles and funicles (cords of tissue distal to the first follicle, and between other follicles [*cf. R.A.E.*, B **47** 190; **48** 215]). Notes are given on the appearance of the ovarioles and on that of free funicles throughout the gonotrophic cycle. Parous females were recognised by the presence, in some of the ovarioles, of a funicle stump composed of second or later funicles ending in a fragment of an old follicle.

LaBrecque (G. C.), Gahan (J. B.) & Adcock (P. H.). **Residual effectiveness of six organophosphorus compounds against** *Anopheles quadrimaculatus* **Say.**—*Mosq. News* **18** no. 2 pp. 94–95, 5 refs. Albany, N.Y., 1958.

The development of resistance to chlorinated-hydrocarbon insecticides has been reported in five species of *Anopheles* [*R.A.E.*, B **47** 71; **48** 210], and organophosphorus compounds have been used successfully against larvae and adults of other mosquitos resistant to chlorinated hydrocarbons [**46** 107; **47** 203]. In 1957, a series of duplicate tests was carried out in the laboratory to compare the duration of effectiveness of deposits of malathion, diazinon, Dow ET-57 [O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate], trichlorphon (Dipterex), dicapthon (Am. Cyanamid 4124 [O,O-dimethyl O-2-chloro-4-nitrophenyl phosphorothioate]), Chlorthion and DDT against adults 3–4 days old of undetermined sex from a non-resistant colony of *A. quadrimaculatus* Say. Acetone solutions of the insecticides were sprayed on plywood panels at a rate of 100 mg. active ingredient per sq. ft., and the panels were tested after aging for 1–180 days. In each test, 20–40 mosquitos were exposed on these panels for periods ranging from 5 to 120 minutes, then transferred to cylindrical screen cages where they were provided with a 10 per cent. sugar solution, and kept for 24 hours, after which mortality counts were made. Malathion was equal or superior to DDT, giving 100 per cent. mortality in 60-minute exposures throughout the 180-day test period, and also in 30-minute exposures for up to 14 days, and at least 91 per cent. thereafter. Diazinon was more effective than malathion for the first 14 days, about equal to it after 30–60 days, and then slightly less effective. Dow ET-57 was also more effective than malathion in the first 14 days, but much less effective thereafter. Am. Cyanamid 4124 was slightly less effective than malathion, giving 100 per cent. mortality for up to 150 days in 60- and throughout the test in 120-minute exposures. Chlorthion and trichlorphon were less effective.

Bellamy (R. E.) & Kardos (E. H.). **A strain of** *Culex tarsalis* **Coq. reproducing without blood meals.**—*Mosq. News* **18** no. 2 pp. 132–134, 8 refs. Albany, N.Y., 1958.

Chao (J.). **An autogenous strain of** *Culex tarsalis* **Coq.**—*T.c.* pp. 134–136, 5 refs.

In the first paper, it is stated that a colony of *Culex tarsalis* Coq. was established at Bakersfield, California, from wild stocks collected in the vicinity in 1952–56. In 1957, some females that had not taken a blood-meal were observed to have partly developed ovaries. A sub-colony, consisting of about 100 unfed females (many of which had partly developed ovaries) and about 200 males, was set up and opportunity to feed on a chicken was given several times over a fortnight. Some of the females fed, and the

sub-colony was thereafter maintained without blood for about six generations, over a period of four months. Adults, like those of the blood-fed colony, were provided with maize syrup and occasionally apple slices, but some deposited egg-rafts even when no such food was provided. The larvae were fed on pellets of a high-protein cattle-feed; when they were given only small amounts of this, the tendency for spontaneous development of the ovaries was reduced. Females have occasionally been found in local wild populations of *C. tarsalis* with partly developed ovaries, and when larvae, from eggs deposited by wild *C. tarsalis*, were fed on the same high-protein diet as the autogenous colony, they gave rise to females that showed some autogeny. In natural breeding areas, food supply may not be rich enough to stimulate autogenous ovarian development. The egg-rafts of the autogenous colony were smaller than the normal ones, so that the size of egg-rafts is not necessarily an indication of the extent of blood-feeding.

It is stated in the second paper that a laboratory colony of *C. tarsalis* was established from egg-rafts of the Bakersfield colony, and has been maintained in Los Angeles since 1954. In September and November 1955, and again in November 1957, egg-rafts were observed in cages of adults that had not had a blood-meal, and an autogenous sub-colony from the last egg-rafts was maintained for three months, by which time it had reached the fifth generation. The adults were fed on apple slices, and the larvae on fresh yeast with occasional addition of Purina chow; the anautogenous strain was maintained in the same way, except that it was given the opportunity to feed on canaries at irregular intervals. The time taken for completion of the life-cycle was about the same for both strains, but the autogenous one laid fewer egg-rafts, each of which contained fewer eggs, of which a lower percentage hatched, than the other strain. The number of eggs in both strains was much lower than at Bakersfield; this may have been due to differences in food or laboratory procedure, or to changes in populations that have developed in the different environments.

Hayes (R. O.) & Doane jr. (O. W.). **Primary record of *Culiseta melanura* biting man in nature.**—*Mosq. News* **18** no. 3 pp. 216–217, 6 refs. Albany, N.Y., 1958.

The virus of eastern equine encephalitis has been isolated from *Culiseta melanura* (Coq.) collected in the south and east of the United States [*cf. R.A.E.*, B **45** 97]. This mosquito is thought to be mainly an avian feeder [*cf.* **47** 66] and may spread the virus among wild birds. In the laboratory it has been induced to feed on fowl, occasionally on rabbits [**45** 97], on mice and once on man. In 1957, a female alighted on the arm of one of the authors in a cedar swamp at Raynham, Massachusetts, punctured the skin after about five minutes, and was allowed to bite for ten minutes. A typical wheal was produced in the area of biting. Microscopical examination revealed only a small amount of undigested blood from a previous meal. Adults of *C. melanura* have been collected in this swamp on several occasions, but were not observed to bite. If this mosquito is the principal vector of human eastern equine encephalitis, the infrequency of its feeding on man might account for the small numbers of human cases reported.

Hayes (R. O.), Bellamy (R. E.), Reeves (W. C.) & Willis (M. J.). **Comparison of four sampling methods for measurement of *Culex tarsalis* adult populations.**—*Mosq. News* **18** no. 3 pp. 218–227, 1 graph, 4 refs. Albany, N.Y., 1958.

The following is substantially the authors' summary. Four methods of collecting adults of *Culex tarsalis* Coq. were compared over a period of more

than a year, in 1953–54, at three localities in Kern County, California. The collections were made by aspirator in natural shelters and in artifical shelters consisting of red boxes of 1 cu. ft. capacity, by light-traps, and by traps baited with carbon dioxide. All methods were satisfactory for measuring the abundance of adult females in summer, and all except the bait traps were adequate for collecting males. There was close agreement between the population trends indicated by the different collecting methods within single areas and by each collecting method in the three localities.

Elmore jr. (C. M.) & Fay (R. W.). *Aedes sollicitans* **and** *A. taeniorhynchus* **larval emergence from sod samples.**—*Mosq. News* **18** no. 3 pp. 230–233, 1 ref. Albany, N.Y., 1958.

The following is substantially the authors' summary. Results from flooding sod samples of *Distichlis spicata* taken from an area of salt-marsh in Georgia with uniform elevation and plant growth showed that estimates of the production potential of *Aëdes sollicitans* (Wlk.) and *A. taeniorhynchus* (Wied.) may be influenced by temperature before and at the time of flooding, by the forms on which the counts and identifications were based (whether first-instar larvae, fourth-instar larvae, or emerging adults), by the wide range in numbers of eggs per sample from relatively small areas and by the season of the year in which samples were taken from the field.

Fowler jr. (H. W.), Murdoch (W. P.), Bullock (H. R.), Parker (W. H.) & Baumgardner (H. D.). **A simple insectary artificial light controller.** —*Mosq. News* **18** no. 3 pp. 234–235, 2 figs., 3 refs. Albany, N.Y., 1958.

The following is taken mainly from the authors' summary. A simple artificial light controller used to provide the special lighting conditions required in the insectary by a colony of *Culex tritaeniorhynchus* Giles [*R.A.E.*, B **46** 197] is described. It can be constructed from materials found in most laboratories. The controller is designed to operate on a 24-hour cycle and supplement the short day-light periods of winter with two 3-hour periods of illumination that are automatically controlled and simulate dawn and dusk.

Weidhaas (D. E.) & Gahan (J. B.). **Effect of certain changes in testing technique on mortality of mosquito larvae.**—*Mosq. News* **18** no. 4 pp. 275–279, 4 refs. Albany, N.Y., 1958.

Variations in mortality obtained with different techniques that are used in the laboratory to determine the toxicity of chemicals to mosquito larvae [*R.A.E.*, B **45** 140, etc.; **48** 22] are not fully explained. The effect of the more obvious variables was tested in experiments carried out at Orlando, Florida, by the exposure of laboratory-reared larvae of *Anopheles quadrimaculatus* Say and *Aëdes taeniorhynchus* (Wied.) to DDT in suspension in water from acetone solutions. The variables studied were the susceptibility of different instars and the volume of the suspension for both species, and the quantity of acetone per container, the method of preparing the DDT suspensions and the feeding or starving of the larvae before the test for *Anopheles*. Duplicate vessels containing five or six concentrations of DDT were used, ranging from 0·001 to 0·05 part per million for *Anopheles* and 0·005–0·1 p.p.m. for *Aëdes*. The mortality was recorded after 24 and 48 hours, and the LC50's and LC90's were calculated.

In both species, the susceptibility to DDT decreased with the age of the larvae. The LC50's and LC90's for *Aëdes* larvae from a DDT-resistant colony showed a much greater increase between the second and fourth instars than did those for the *Anopheles* larvae. When the results obtained with 0·25 l. suspension per vessel were compared with those obtained with 1 l., the LC50's and LC90's were significantly lower for the lower volume at 48 hrs., but not significantly different at 24 hrs., with *Anopheles*, whereas with *Aëdes* they were significantly lower for the higher volume at 24 hrs., but not significantly different at 48 hrs. It seems that the amount of DDT available was not the only factor controlling mortality. There was no significant difference in mortality in suspensions containing 1, 2 or 5 ml. acetone when larvae were added immediately after the suspension had been made, and when they were added after an interval of four hrs., the only significant difference was in the LC90 with 5 ml. acetone. Addition to the water of various concentrations of DDT in a uniform volume of acetone gave lower LC50's and LC90's than addition of the same concentration of DDT in various volumes, but the slopes of the regression lines were not significantly different. There was no significant difference in mortality between larvae fed up to the time of testing and those starved for four hours.

Love (G. J.) & Smith (W. W.). **The stratification of mosquitoes.**—*Mosq. News* **18** no. 4 pp. 279–283, 1 graph, 18 refs. Albany, N.Y., 1958.

The following is almost entirely based on the authors' summary. Weekly collections of mosquitos were made with mechanical sweeping devices without baits at six heights between 3 and 50 ft. above the ground in a wooded area next to a breeding site in south-western Georgia in 1954–56. Results indicated that the aerial distribution of various genera conforms to different patterns. *Anopheles* (*A. crucians* Wied. and *A. quadrimaculatus* Say) and *Uranotaenia* rarely reached an altitude of 15 ft. *Aëdes* (*A. infirmatus* D. & K. and *A. vexans* (Mg.)) and *Psorophora* were more active at higher, and *Culex* at intermediate, elevations. *Culiseta* was evenly distributed from six to 50 ft. There were correlations between the vertical distribution of the mosquitos and their feeding habits.

Favorite (F. G.) & Davis (R.). **Some observations on the mosquito fauna of the Okefenokee Swamp.**—*Mosq. News* **18** no. 4 pp. 284–287, 1 map, 5 refs. Albany, N.Y., 1958.

The virus of eastern equine encephalitis was isolated from *Anopheles crucians* Wied., *Aëdes mitchellae* (Dyar) and *Culicoides* spp. collected in south Georgia in 1956, and cases of the disease have occurred in equines near the Okefenokee Swamp. Collections of mosquitos were made at Floyd Island in that swamp and at a tourist camp on its eastern edge in June 1957, and at the same camp and another to the west of the swamp in September 1957. *Anopheles quadrimaculatus* Say was not taken in the swamp, the acid waters of which are not favourable to its breeding, but was taken in small numbers at the eastern camp during both visits. There was a high percentage of *Culiseta melanura* (Coq.), *Mansonia perturbans* (Wlk.) and *A. crucians*, all vectors of eastern equine encephalitis, in the fringe areas, and *M. perturbans* was also taken in large numbers attempting to bite in the swamp. Four species of *Aëdes* were caught on Floyd Island, and a fifth at the eastern camp, in June, but no *Aëdes* were taken in the September collections. Of 89 pools formed from the mosquitos collected, and inoculated into young mice, none produced a recognisable disease.

Rush (W. A.), Brennan (J. M.) & Eklund (C. M.). **A natural hibernation site of the mosquito *Culex tarsalis* Coquillett in the Columbia River Basin, Washington.**—*Mosq. News* **18** no. 4 pp. 288–293, 2 figs., 8 refs. Albany, N.Y., 1958.

The following is based mainly on the authors' discussion and summary. Observations on true hibernation (involving accumulation of fat-body, lack of feeding, absence of males and quiescence) of *Culex tarsalis* Coq. were made in natural sites (loose rock at the bases of volcanic outcrops) in the Columbia River basin, Washington, in 1956–57. As larvae were found in the autumn, and almost all the hibernating females were in a fresh condition, had no undigested blood or developing eggs, and gave negative results when tested for western equine encephalitis virus, it seems that blood-engorged females do not hibernate successfully and do not maintain the virus through the severe winters of northern climates.

Beadle (L. D.) & Harmston (F. C.). **Mosquitoes in sewage stabilization ponds in the Dakotas.**—*Mosq. News* **18** no. 4 pp. 293–296, 6 figs. Albany, N.Y., 1958.

The following is virtually the authors' summary. A survey in 25 counties in South Dakota and North Dakota was conducted in 1956 to determine if sewage stabilisation ponds are an important source of mosquitos. Larvae were not found in eight of 26 ponds inspected, but *Culex tarsalis* Coq. was found in the remaining 18. Mosquito production was classified as light in eight ponds, moderate in two and heavy in eight. More than 99 per cent. of the larvae collected were *C. tarsalis*. Wherever mosquitos were found, vegetation (terrestrial or aquatic) was present; when weed growth was absent or minimal, mosquito production was negative or of little consequence. It was therefore concluded that stabilisation ponds with vegetation had a high production potential for *C. tarsalis*, and those without vegetation, a low mosquito potential.

Bennington (E. E.), Blackmore (J. S.) & Sooter (C. A.). **Soil temperature and the emergence of *Culex tarsalis* from hibernation.**—*Mosq. News* **18** no. 4 pp. 297–298, 1 graph, 10 refs. Albany, N.Y., 1958.

The following is based mainly on the authors' summary. Observations in Colorado in 1953–56 showed that females of *Culex tarsalis* Coq. emerged from hibernation at or soon after the spring soil temperature inversion, when the surface soil becomes warmer than the subsoil. Two females of *C. tarsalis* were taken in 1955 during the spring emergence from wild rodent burrows, and four were recovered after successful hibernation in an artificial burrow.

Bennington (E. E.), Sooter (C. A.) & Baer (H.). **The diapause in adult female *Culex tarsalis* Coquillett (Diptera: Culicidae).**—*Mosq. News* **18** no. 4 pp. 299–304, 3 graphs, 9 refs. Albany, N.Y., 1958.

The following is substantially the authors' summary. A population of *Culex tarsalis* Coq. from a natural resting place near Platteville, Colorado, was studied throughout the 1955 season. Individuals from this population in cages developed fat-bodies without taking blood. Further observations indicated that, in this species, autumn broods emerge, mate and take carbohydrate, after which the females enter a diapause to develop fat-bodies.

These females hibernate and emerge in the following spring to take their first blood-meal for ovarian development. This diapause in late broods of *C. tarsalis* suggests that the species does not maintain encephalitis viruses through the winter.

Chamberlain (R. W.), Sudia (W. D.), Burbutis (P. P.) & Bogue (M. D.). **Recent isolations of arthropod-borne viruses from mosquitoes in eastern United States.**—*Mosq. News* **18** no. 4 pp. 305–308, 11 refs. Albany, N.Y., 1958.

The following is substantially the authors' summary. Encephalitis viruses have been isolated several times from mosquitos in the eastern United States [*cf. R.A.E.*, B **44** 136; **47** 7]. Western equine encephalitis was isolated in North Carolina in 1955 from a pool of engorged females of *Culex pipiens* L. In New Jersey in 1956, eastern equine encephalitis was isolated twice from engorged *C. salinarius* Coq. and once from engorged and twice from non-engorged *Culiseta melanura* Coq.; western equine encephalitis was isolated once from non-engorged *C. melanura*.

Liles (J. N.) & Dunn (P. H.). **Preliminary laboratory results on the susceptibility of** *Aedes aegypti* **(Linnaeus) to** *Bacillus thuringiensis* **Berliner.**—*J. Insect Path.* **1** no. 3 pp. 309–310. New York, N.Y., 1959.

Details are given of preliminary tests showing that *Bacillus thuringiensis* is infective for larvae of *Aëdes aegypti* (L.). A powder containing 155 × 10^9 spores per g. was used, and 1 g. of this per litre of water killed most larvae in the third instar, with very few reaching the fourth. At 0·4 g. per litre, larvae reared from the second instar did not die until they reached the fourth instar or pupal stage, and most fourth-instar larvae added to the water pupated before death occurred. At 0·2 g., development was retarded and the number of adults produced slightly reduced. A high concentration would therefore be required for field control.

Wang (Yi-min), Liu (Chung-wan), Chang (Sing) & Cheng (Yun-kai). **Studies on vectors of Japanese B encephalitis virus in Peking. I. Preliminary report on the survey of mosquitoes.** [*In Chinese.*]—*Acta ent. sin.* **8** no. 4 pp. 317–326, 3 graphs, 22 refs. [Peking] 1958. (With a summary in English.)

In 1953–55, 19 species of mosquitos were collected in and around Peking. *Culex pipiens pallens* Coq. and *C. tritaeniorhynchus* Giles were the commonest in the residential areas, the former being found resting in dark places in houses and the latter in animal quarters together with *Anopheles hyrcanus sinensis* Wied., *A. pattoni* Chr., *Aëdes dorsalis* (Mg.) and *A. vexans* (Mg.). *A. chemulpoensis* Yam. was found in shaded places outdoors. *C. p. pallens*, which was prevalent in June–September, overwinters in unheated premises, and was found breeding in many kinds of water in and around Peking, while *C. tritaeniorhynchus* was mostly confined to the suburbs. Seasonal distribution was determined by periodical collection of adults in selected places, daily collection in animal quarters and periodical collection of larvae and pupae. In these counts, *C. p. pallens* and *C. tritaeniorhynchus* showed two peaks in each year, and from the ecology of the mosquitos and the seasonal and regional distribution of human cases of Japanese B

encephalitis, it is concluded that these two mosquitos are the most important vectors of the virus [*cf. R.A.E.*, B **40** 162–163; **46** 59].

Jeffery (G. M.). **Infectivity to mosquitoes of *Plasmodium vivax* following treatment with chloroquine and other antimalarials.**—*Amer. J. trop. Med. Hyg.* **7** no. 2 pp. 207–211, 5 refs. Baltimore, Md., 1958.

The following is based largely on the author's summary. In 20 cases of malaria caused by *Plasmodium vivax* of the Chesson strain [*R.A.E.*, B **44** 28] that were treated with chloroquine, infectivity to *Anopheles quadrimaculatus* Say ceased as a rule after the first post-treatment day; in two cases only, it ceased after the second. In three cases treated with at least 100 mg. chlorguanide, infectivity to mosquitos ended within the first 24 hours. In one instance, infectivity was interrupted after 24 hours by a single 50-mg. dose of chlorguanide, but then returned and persisted as long as sufficient parasites were present. In a single case treated with 25 mg. pyrimethamine, infectivity was eliminated within four hours. However, a case resistant to this drug readily infected mosquitos during and after multiple daily doses. Intramuscular sodium bismuth thioglycollate at 0·1 g. temporarily eliminated gametocytes and infectivity to mosquitos within 24–48 hours, but both reappeared after one or two days.

Fox (R. M.). **Man-biting mosquitoes in coastal Liberia.**—*Amer. J. trop. Med. Hyg.* **7** no. 2 pp. 215–220, 16 refs. Baltimore, Md., 1958.

Records, with data on prevalence and seasonal distribution, are given of some 24 man-biting species of mosquitos collected in 1954–56 in coastal Liberia, in country of four ecological types, by hand-catching on man in the open, trapping on man in a portable trap at night, and hand-catching in native houses in the morning. Three species of *Mansonia*, seven of *Aëdes* and eight of *Culex* were taken by these means, in addition to Anophelines. Among the latter, *A. gambiae* Giles and *A. g. melas* Theo., which the author treats as a distinct species, were the predominant man-biting mosquitos, the former being common throughout the year. They were discussed elsewhere [*R.A.E.*, B **45** 129–130; **47** 157]. *A. funestus* Giles was very rare, presumably as a result of house spraying. The others were *Anopheles coustani* var. *ziemanni* Grünb. (treated as a distinct species), *A. paludis* Theo. and *A. hancocki* Edw. [*cf.* **44** 198], and small numbers of females of each were dissected for malaria parasites and filarial larvae. The only positive finding was of two second-stage larvae, possibly of *Wuchereria bancrofti*, in a female of *A. paludis*. Light-trapping and collection of larvae yielded four additional species, two of *Anopheles* (*barbirostris* Evans and *hargreavesi* Evans) and two of *Culex*; these evidently do not feed on human blood. *Aëdes argenteopunctatus* (Theo.) and *Culex galliardi* Edw., which was taken on man in the trap, are recorded from Liberia for the first time.

Smith (W. W.) & Love (G. J.). **Winter and spring survival of *Aedes aegypti* in southwestern Georgia.**—*Amer. J. trop. Med. Hyg.* **7** no. 3 pp. 309–311, 1 graph. Baltimore, Md., 1958.

The following is based on the authors' summary. Weekly observations were made throughout the winter of 1956–57 at Thomasville, Georgia, on the effects of low temperature on the survival and development of larvae of *Aëdes aegypti* (L.) [*cf. R.A.E.*, B **46** 73, etc.] in various types of breeding

containers in an experimental plot and throughout the city and in incidental containers at premises in residential areas. Average weekly temperatures below 60°F. killed most larvae, but, because of the sheltered positions of some containers, a few survived during periods when the average weekly temperature was 48°F. During the warmer parts of the winter, larval development continued and adults emerged. No indications of feeding or oviposition were observed during the colder months. Normal breeding and oviposition apparently began in May.

KARTMAN (L.), PRINCE (F. M.) & QUAN (S. F.). **Studies on *Pasteurella pestis* in fleas. VII. The plague-vector efficiency of *Hystrichopsylla linsdalei* compared with *Xenopsylla cheopis* under experimental conditions.**—*Amer. J. trop. Med. Hyg.* **7** no. 3 pp 317–322, 1 graph, 8 refs. Baltimore, Md., 1958.

The methods and materials used in the experimental studies on *Hystrichopsylla linsdalei* Holl. and *Pasteurella pestis* reported in this seventh paper of a series [*cf. R.A.E.*, B **47** 158, etc.] were the same as those described in previous reports on the plague-vector efficiency of fleas [**46** 162–163; **47** 58], but the average temperature at which infected fleas were kept (19°C. [66·2°F.]) was lower than in the previous tests with *H. linsdalei*. Some fleas of this species became blocked sooner after the infective meal than did any examples of *Xenopsylla cheopis* (Roths.), but the rate of blocking in the latter was much more rapid, and 48 per cent. of the fleas became blocked, as compared with only 19 per cent. in *H. linsdalei*. Males of both species became blocked more rapidly than females [*cf.* **46** 163]. The plague-vector indices of both sexes combined were 0·002 for *H. linsdalei* and 0·03 for *X. cheopis*. *H. linsdalei* had a higher infection potential [**46** 163] than *X. cheopis* and a shorter incubation period, but a much lower blocking potential and a shorter survival period after blocking, resulting in fewer opportunities to transmit. There was no evidence that feeding on different mice with comparable plague infections influenced subsequent infection or blocking rates in the fleas, and the differences between the two species suggested the existence of unknown physiological dissimilarities between them. Mice succumbing to plague transmitted by *H. linsdalei* died in an average of about five days after infection, and mice infected by *X. cheopis* in about four days. This suggests that *H. linsdalei* may inject fewer bacilli than *X. cheopis*. In confirmation of past work [*cf.* **46** 163, etc.], it was found that culture of faeces from and microscopic observation of fleas infected with *P. pestis*, though useful, do not provide a reliable means of determining infection in individual fleas. The culture of individual fleas is the method of choice.

GRESSER (I.), HARDY (J. L.), HU (S. M. K.) & SCHERER (W. F.). **Factors influencing transmission of Japanese B encephalitis virus by a colonized strain of *Culex tritaeniorhynchus* Giles, from infected pigs and chicks to susceptible pigs and birds.**—*Amer. J. trop. Med. Hyg.* **7** no. 4 pp. 365–373, 14 refs. Baltimore, Md., 1958.

The following is substantially the authors' summary. *Culex tritaeniorhynchus* Giles, the principal mosquito to become infected with the virus of Japanese B encephalitis in nature in Japan [*R.A.E.*, B **40** 163], was shown,

after colonisation and propagation for 12–17 generations in the laboratory, to transmit the virus readily from chick to chick and from pig to pig, black-crowned night heron [*Nycticorax nycticorax*], egrets [*Egretta*] [*cf.* **48** 166] and baby chicks. Mosquito infection and transmissions followed ingestion of blood containing as little as three mouse-LD50's of virus per 0·04 ml. blood (0·15 LD50 per mosquito). The concentration of virus in the blood of the host chick or pig determined the proportion of mosquitos infected and, consequently, the over-all transmission rate, although some infected mosquitos failed to transmit virus. Virus was recovered from mosquitos within a few days of feeding on an infective animal, but transmission usually did not occur until more than two weeks after ingestion of infective blood.

Galindo (P.). **Bionomics of *Sabethes chloropterus* Humboldt, a vector of sylvan yellow fever in middle America.**—*Amer. J. trop. Med. Hyg.* **7** no. 4 pp. 429–440, 10 figs., 11 refs. Baltimore, Md., 1958.

Yellow fever has been transmitted to monkeys by *Sabethes chloropterus* (Humb.) [*R.A.E.*, B **47** 58], and the virus has been isolated from this species [**47** 158]. A colony of *S. chloropterus* was established in cages 1 cu. m. in size in a laboratory in Panama, where it has been maintained for over two years, and observations on the bionomics of this mosquito are reported. The following is based on the author's summary. Sugar solution was given to the colony, and a rhesus monkey [*Macaca mulatta*] or guineapig was provided daily as a source of blood for the females. A section of bamboo, about 1·5 in. in diameter, with a lid, a hole 1 in. in diameter in its side and half-filled with water was provided for oviposition. Larvae were reared in a yeast-infusion medium in enamel pans. The mosquito is strictly diurnal in habits [**41** 80], and the females seek blood-meals in the early afternoon. Both sexes became engorged on sugar solution 6–24 hours after emergence. No female was observed to take blood before the fifth day after emergence, and biting activity was maximal in the second or third week. Females prefer to bite high on the body, especially on the nose and lips. Mating was not observed before the sixth day after emergence and was commoner in the second or third week of the female's life. In an experiment, males and females were kept together and given the opportunity to feed daily on a monkey, and the females that engorged were removed, kept for six days, and then dissected to determine the rate of insemination and the extent of ovarian development. Insemination did not always occur before the first blood-meal, and did not seem to be essential for ovarian development, as 45 per cent. of the females were inseminated but 95 per cent. showed full ovarian development. The position of the sun in the sky rather than light intensity seems to be the main factor inducing oviposition, and the largest number of eggs was laid in the early afternoon. The species is anautogenous. Oviposition usually began on the third day after a blood-meal and continued for 13 days. Females laid 2–103 eggs each after a single blood-meal, and an average of 138 eggs during life. The eggs hatch in 3–4 days and are incapable of entering into a prolonged diapause. The larvae are facultatively predacious and cannibalistic, but rarely attack larvae of their own species in the same instar. At 26°C. [78·8°F.], the larval and pupal stages lasted 9–28 and about 5–7 days, respectively. The mean length of life of females after the first blood-meal was 38·9 days with a maximum of 140 days; 50 per cent. of them lived for 5–6 weeks after the initial blood-meal and 10 per cent. were still alive 9–10 weeks after it.

Jungherr (E. L.) & Wallis (R. C.). **Investigation of eastern equine encephalomyelitis. I. General aspects.**—*Amer. J. Hyg.* **67** no. 1 pp. 1–3. Baltimore, Md., 1958.

Luginbuhl (R. E.), Satriano (S. F.), Helmboldt (C. F.), Lamson (A. L.) & Jungherr (E. L.). **II. Outbreaks in Connecticut pheasants.**—*T. c.* pp. 4–9, 2 figs.

Jungherr (E. L.), Helmboldt (C. F.), Satriano (S. F.) & Luginbuhl (R. E.). **III. Pathology in pheasants and incidental observations in feral birds.**—*T. c.* pp. 10–20, 12 figs.

Satriano (S. F.), Luginbuhl (R. E.), Wallis (R. C.), Jungherr (E. L.) & Williamson (L. A.). **IV. Susceptibility and transmission studies with virus of pheasant origin.**—*T. c.* pp. 21–34, 1 graph.

Wallis (R. C.) & others. **V. Entomologic and ecologic field studies.**—*T. c.* pp. 35–45, 57 refs.

The first of these papers forms a general introduction to this study of eastern equine encephalitis in Connecticut, where the disease does not occur in man but was reported in pheasants in 1938 [*cf. R.A.E.*, B **29** 38]. With the exception of one histologically positive pheasant specimen in 1947, no further evidence of its presence in the State was obtained until 1951. Information on outbreaks in domestic pheasants in 1951, 1953, 1955 and 1956 are given in the second paper. Most of them were detected during investigation of excessive mortality in young birds. Those in 1951 were all fairly near the coast, but from 1953 onwards they occurred inland also. It is further stated that nine outbreaks have occurred in horses since 1938. They were not closely associated with those in pheasants, and both horse and pheasant appear to be accidental hosts. Antibodies were found to persist for at least 16 months in pheasants that had recovered from a natural infection.

The third paper contains an account of gross, clinical and histopathological features of the disease in pheasants and the results of incidental observations on various wild birds, and the fourth contains the results of experiments on the susceptibility of horses, calves and birds to virus of pheasant origin and on direct transmission from bird to bird. Three controlled experiments in 1953–54 showed that heavy mortality in epizootics is probably correlated with feather picking and cannibalism among penned pheasants.

In the fifth paper, the results are summarised of a study made in 1953–56 on mosquito and wild-bird populations and ecology on 20 of the farms on which the disease caused deaths in horses or pheasants in 1938–56. Four of the farms were in marshy coastal areas and 16 inland, and all were in or near mixed woodland areas adjacent to fresh-water swamps or swampy or seepage woodland that permitted abundant mosquito breeding and harboured an abundance of wild birds of various kinds, both resident and migratory. On 14 of the farms, investigations were begun in late summer as soon as virus activity was reported, and two areas, representative of the two ecological types, were chosen for intensive study. The mosquito population consisted mostly of woodland species. *Culex restuans* Theo. and *Aëdes triseriatus* (Say), recently rated as good and excellent potential vectors, respectively [*cf.* **44** 40], predominated among these, and, like *A. vexans* (Mg.) and *C. pipiens pipiens* L., were found in all the known infected areas, as were other species that were less plentiful or are not known to be good vectors. Salt-marsh species, including *A. sollicitans* Wlk. [**44** 40], were restricted to the four coastal areas, which reduced their potential importance as vectors. *Culiseta melanura* (Coq.) [*cf.* **47** 66] was not proved to occur throughout the State, but species of this genus were observed to become numerous and to feed round pheasant pens in early summer. Peak mortality

among pheasants occurred in late September or early October, when mosquito activity had diminished with the onset of cool weather and early frosts, but, in each case, the first deaths had occurred 1–3 weeks earlier, while mosquitos were active, and the introduction of the disease into a flock is attributed to them, whereas later transmission, with cases occurring in rapid succession but not spreading from pen to pen, evidently results from contact within the pens. Mosquito pools comprising a total of 5,862 females were tested for virus, but all the results were negative. It is suggested that the forests and woodland that cover two-thirds of Connecticut provide a sylvan environment in which virus-disseminating wild birds and potential mosquito vectors are so widely dispersed that the disease remains essentially an agricultural and wildlife problem. An adequate percentage of infection is not reached in the mosquito population for effective transmission to man.

Reeves (W. C.), Bellamy (R. E.) & Scrivani (R. P.). **Relationships of mosquito vectors to winter survival of encephalitis viruses. I. Under natural conditions.**—*Amer. J. Hyg.* **67** no. 1 pp. 78–89, 1 graph, 10 refs. Baltimore, Md., 1958.

Bellamy (R. E.), Reeves (W. C.) & Scrivani (R. P.). **II. Under experimental conditions.**—*T. c.* pp. 90–100, 11 refs.

Little is known of the survival of mosquito-borne viruses through periods adverse to transmission. In the first of these papers, an account is given of intensive studies of virus survival in winter, under natural conditions, begun in 1950 in Kern County, south-central California, a highly endemic area for western equine encephalitis (WEE) and St. Louis encephalitis (SLE). Collections of *Culex tarsalis* Coq., the chief vector, were made throughout the year from 1950 to 1955 in various resting sites in four localities in which the viruses reappeared regularly each summer with high infection rates in this mosquito. WEE virus was isolated from females collected in all months of the year except December and reached its peak of incidence in May–July. Strains isolated in January–March were often non-pathogenic for mice and produced little antibody response in inoculated chickens. The virus was isolated from three of four pools of *C. tarsalis* that had been collected in January–February 1954 and survived in a cellar until April. The monthly pattern of isolations showed close correlation with the feeding activities of *C. tarsalis*, and the virus could not be detected from 15th November to 15th January when blood feeding was minimal. Particularly high incidence of WEE infection in *C. tarsalis* in the spring of 1954 followed prolonged activity in the preceding summer but did not lead to a build-up of infection in mosquitos in the next summer. It is considered as likely that a vertebrate host is the immediate source of winter infection in mosquitos as that the virus survives solely in the vector in winter. SLE virus was found in *C. tarsalis* only in June–September, except for one finding in March. It predominated over WEE in August and September.

The second paper is concerned with virus survival, under experimental conditions, and the following is based on the authors' summary of the results. WEE virus persisted in laboratory-infected females of *C. tarsalis* at 55°F. for 41 days after the mosquitos had reached the infective phase at 75–84°F. Under similar circumstances, SLE virus persisted in *C. pipiens pipiens* L. for 31 and in *C. p. fatigans* Wied. (*quinquefasciatus*, auct.) for 14 days. WEE virus survived for up to 113 days in experimentally infected females of *C. tarsalis* kept in winter in an unheated cellar, and SLE virus survived for 116 days in *C. p. fatigans* under similar conditions. In a normal winter, temperatures in such cellars fell to 50–60°F. in January and February. *C. tarsalis* completed extrinsic incubation and transmitted WEE virus to

chickens after 97 and 109 days of winter incubation. The infected chickens circulated virus in sufficient titre to infect normal females of *C. tarsalis*, and these in turn survived and retained WEE virus until early spring. It is concluded that experimentally infected females of *C. tarsalis* can carry WEE virus through the winter by serial transmission. However, the possibility that the virus overwinters in nature in a chronically infected avian host cannot be excluded. The data on the persistence of SLE virus were too limited for conclusive interpretation.

Kitzmiller (J. B.) & Laven (H.). **Tests for multiple fertilization in *Culex* mosquitoes by the use of genetic markers.**—*Amer. J. Hyg.* **67** no. 2 pp. 207–213, 8 refs. Baltimore, Md., 1958.

The following is based on the authors' summary. From the results of the experiments described, which were made possible by the availability of suitable genetic markers [*cf. R.A.E.*, B **45** 135] for *Culex pipiens molestus* Forsk. and *C. p. fatigans* Wied., it appears that each egg-raft deposited by females of these mosquitos represents a fertilisation by sperm from a single male. No attempt is made to describe the physiological mechanism involved. With possibly a few exceptions, it seems safe to analyse rafts from mass cultures in the usual genetic sense and to treat them as F_1, F_2 or backcross progeny.

Rosen (L.). **Observations on the epidemiology of dengue in Panama.**—*Amer. J. Hyg.* **68** no. 1 pp. 45–58, 1 map, 27 refs. Baltimore, Md., 1958.

In an investigation in 1954 on the epidemiology of dengue in Panama, where the disease was suspected of being endemic, dengue-neutralising antibodies were not found in the sera of persons born since 1942, were relatively infrequent in the sera of older persons living in forested areas (though frequent in town dwellers) and were absent from the sera of monkeys known to be susceptible to infection. It is concluded that the disease is not endemic in Panama and has not occurred there since 1942. As the known vectors all belong to the subgenus *Stegomyia* of *Aëdes*, which, except for *A. aegypti* (L.), is restricted to the Old World, it appears that dengue will be eliminated from the Western Hemisphere when the current programme for the eradication of *A. aegypti* [*R.A.E.*, B **46** 108] has been completed. *A. aegypti* had apparently been eradicated from Panama by the time of the investigations, as a result of an intensified campaign begun in 1949.

Duke (B. O. L.). **The intake of the microfilariae of *Acanthocheilonema streptocerca* by *Culicoides milnei*, with some observations on the potentialities of the fly as a vector.**—*Ann. trop. Med. Parasit.* **52** no. 2 pp. 123–128, 7 refs. Liverpool, 1958.

Experiments were carried out in the British Cameroons, on a volunteer whose skin was heavily infected with microfilariae of *Dipetalonema* (*Acanthocheilonema*) *streptocerca* and whose blood was very lightly infected with microfilariae of *D.* (*A.*) *perstans*, in an attempt to ascertain whether *D. streptocerca* can develop in *Culicoides milnei* Aust. [*cf. R.A.E.*, B **45** 202].

When feeding on an area of infected skin (the back and shoulders), eight members of a group of 505 adults of *C. milnei* took in a total of ten microfilariae of *D. streptocerca*, whereas 40 out of a group of 266 adults of *C. grahamii* Aust. feeding on the same area took in a total of 65. The discovery that *C. milnei* takes in so few microfilariae of *D. streptocerca* made it impossible to determine whether development to the infective stage could be completed in the fly, so long as the only available volunteer was one who also had some *D. perstans* in his blood. Although larvae developed in more individuals in a group of *C. milnei* fed on an infected area of skin than in a group fed on a *streptocerca*-free area in which, however, *D. perstans* was present, and the numerical difference appeared to suggest development of *D. streptocerca*, this difference was not statistically significant.

Crosskey (R. W.). **The body weight in unfed** *Simulium damnosum* **Theobald, and its relation to the time of biting, the fat-body and age.**—*Ann. trop. Med. Parasit.* **52** no. 2 pp. 149–157, 2 graphs, 6 refs. Liverpool, 1958.

The following is almost entirely the author's summary. Observations in Northern Nigeria on the body weight of unfed females of *Simulium damnosum* Theo. attempting to bite are described, and the data are assessed statistically. The mean weight of the fly was found to be 1·06 mg., and the range of weight to be from 0·5 to 1·88 mg. It is shown that the mean weight of flies varies with the time at which biting occurs, and that flies are heaviest in the early mornings and late afternoons and lightest when biting between 10 a.m. and 2 p.m. Variation in the mean weight of flies biting at different times of day was closely correlated with the amount of fat-body in the flies; this correlation is shown in histogram form. The proportion of flies without fat-body was greatest in flies collected in the middle of the day, when weight is minimal. The weight of the fully developed fat-body is estimated to be about 0·23 mg. and about 20 per cent. of the weight of the young fly. The weight of the gorged crop was found to be as much as 0·52 mg., or equal to the weight of the lightest flies.

The findings are discussed, and it is shown that young flies, with high average weight, bite mainly in the morning and evening, whereas the older flies, with low average weight, bite mostly about the middle of the day; this is associated with fully-developed fat-body in the young nulliparous flies and with an absence of fat-body in the older parous flies. It is suggested that most flies, even those that are nulliparous, would have little fat-body when living in environments remote from the breeding-sites or where a blood-meal is not obtainable. The results also suggest that the highest infection rates with *Onchocerca volvulus* probably exist (in the area concerned) in flies biting between 10 a.m. and 2 p.m.

Duke (B. O. L.) & Wijers (D. J. B.). **Studies on loiasis in monkeys. I. The relationship between human and simian** *Loa* **in the rain-forest zone of the British Cameroons.**—*Ann. trop. Med. Parasit.* **52** no. 2 pp. 158–175, 4 graphs, 11 refs. Liverpool, 1958.

The following is based on the authors' summary. A comparative study is made of the microfilariae and adult worms of human and simian *Loa* in

various hosts in the rain-forest of the British Cameroons. Infections with a form of *Loa* have been found in *Mandrillus leucophaeus*, *Cercopithecus nictitans martini*, *C. mona mona* and *C. preussi*. Both microfilariae and adults are large, the microfilariae exhibit nocturnal periodicity [*cf. R.A.E.*, B **46** 69–70], and the vectors are believed to be the crepuscular canopy-dwelling *Chrysops langi* Beq. and *C. centurionis* Aust. [**48** 186]. *L. loa* from man was transmitted experimentally to *M. leucophaeus* by inoculation of infective forms developed in *C. silacea* Aust. The mature parasites were small, and the microfilariae maintained their diurnal periodicity. It is believed that under natural conditions, transmission of *L. loa* from man to monkey takes place extremely rarely, and the monkey population is of no practical importance as a reservoir of human loiasis. The human and simian parasites are at an early stage of radiative evolution in separate host-vector complexes, between which parasite interchange is minimal. These complexes comprise *L. loa*, man, *C. silacea* and the Bombe form of *C. dimidiata* Wulp [**48** 186] on the one hand, and simian *Loa*, monkeys, *C. langi* and *C. centurionis* on the other.

SERVICE (M. W.). **A new *Anopheles* from the Southern Cameroons, *Anopheles buxtoni* sp. nov.**—*Ann. trop. Med. Parasit.* **52** no. 2 pp. 176–180, 2 figs., 3 refs. Liverpool, 1958.

Anopheles buxtoni, sp. n., is described from larvae collected near Kumbo in the British Cameroons in 1957 and from a pupal pelt and a laboratory-reared male. The larvae were plentiful under grassy vegetation at the edges of a fairly fast-flowing forest stream, 1–2 ft. deep, at an altitude of 6,000–7,000 ft. Characters distinguishing it from *A. ardensis* (Theo.) and *A. machardyi* Edw., which it closely resembles, are discussed.

WILLIAMS (M. C.), WEITZ (B.) & MCCLELLAND (G. A. H.). **Natural hosts of some species of *Taeniorhynchus* Lynch Arribalzaga (Diptera, Culicidae) collected in Uganda, as determined by the precipitin test.**—*Ann. trop. Med. Parasit.* **52** no. 2 pp. 186–190, 10 refs. Liverpool, 1958.

The sources of the blood-meals taken by 854 females of *Mansonia* (*Taeniorhynchus*) spp. out of 902 collected in two lake-shore forests of Uganda in May–July 1956 were determined by means of precipitin tests. *M. aurites* (Theo.), *M. pseudoconopas* (Theo.), *M. fraseri* (Theo.), *M. maculipennis* (Theo.) and *M. metallica* (Theo.) all gave similar results. Of 850 smears of these species, 810 were positive, 799 for avian and nine for primate blood, one for both and one for reptilian blood. The results for *M. fuscopennata* (Theo.) showed a different pattern; of 52 smears, 29 were positive for primate blood, six for birds and nine for ruminants, of which four reacted with anti-ox serum; this sample may, however, have been too small to be representative. A record of the condition of smears was found to be useful in the evaluation of results. Many of the blood-meals identified as primate were very fresh and had been collected on one day; if this was so because the mosquitos had been caught immediately after feeding on the collectors, the sample would be biased. Most of the negative results were obtained with considerably digested blood-meals, and it is thought that there was little, if any, feeding on hosts with sera with which the antisera used would not react.

Wharton (R. H.), Edeson (J. F. B.), Wilson (T.) & Reid (J. A.). **Studies on filariasis in Malaya: pilot experiments in the control of filariasis due to** *Wuchereria malayi* **in East Pahang.**—*Ann. trop. Med. Parasit.* **52** no. 2 pp. 191–205, 2 figs., 16 refs. Liverpool, 1958.

The following is taken from the authors' summary. Pilot experiments in the control of filariasis caused by *Wuchereria malayi* and transmitted by mosquitos of the subgenus *Mansonioides* of *Mansonia* were carried out in three small Malay settlements in East Pahang [*R.A.E.*, B **48** 186]. Diethylcarbamazine was administered to the whole population weekly for eight weeks in the first settlement and monthly for six months in the second, and the sheltered surfaces of houses were sprayed with dieldrin at 100 mg. per sq. ft. at six-monthly intervals in the third. Weekly or monthly drug administration very considerably reduced microfilarial rates and densities, but both had risen slightly in both areas one year later. Spraying with dieldrin over a period of two years had no effect on the microfilarial rates or densities. Control measures did not make any observable difference in any of the areas to the intensity of transmission, as measured by the biting and infection rates of *M. longipalpis* [a name used by the senior author to include both *M. dives* (Schiner) (*longipalpis* (Wulp)) and *M. bonneae* Edw. (**47** 20)], though observations in houses showed that dieldrin killed large numbers of *M. longipalpis* and drug treatment was shown to effect a ten-fold reduction in the infectivity of the population to mosquitos. It is considered that the lack of observable effect on transmission was partly due to the small areas under control and partly to the presence of an untreated reservoir of infection with *W. malayi* in domestic and forest animals.

Lewis (D. J.). **Observations on** *Simulium damnosum* **Theobald at Lokoja in Northern Nigeria.**—*Ann. trop. Med. Parasit.* **52** no. 2 pp. 216–231, 4 figs., 26 refs. Liverpool, 1958.

The following is virtually the author's summary. Methods used for dissecting and examining adults of *Simulium damnosum* Theo. are described, with particular reference to the recognition of parous females by means of the corpora lutea and other structures in the ovarioles [*R.A.E.*, B **47** 190]. The width of the wing was measured in 723 flies caught in the Lokoja area of Northern Nigeria in 1957, and the curve drawn from the results was about normal. The volume of the crop was roughly estimated, and the pattern of sizes in flies from two areas near Lokoja is recorded. It was found that most nulliparous and all parous flies could, respectively, be recognised, while alive, by the clarity or the opacity of the halteres [*cf.* **41** 38]. The appearance of the corpora lutea and of the ovarioles of nulliparous and parous flies is described, and the significance of the occurrence of several large oocytes in some flies is discussed. It was estimated that, on the average, nulliparous flies lay many more eggs than parous flies. Several other organs are considered, and the physiological state of flies is discussed with particular reference to the character of the local population of *S. damnosum* around Lokoja, and to some obvious ways in which it differed from a Sierra Leone population [**46** 125–126]. It was found that parous flies were relatively numerous among those caught shortly before and after midday [*cf.* **48** 230]. When caught flies were kept without food, many died before 18 hours, while others, mainly nulliparous, survived much longer. Some, at least, of the longer-lived individuals had evidently been well supplied with plant-juice. Examination of flies from an uninhabited hill-top showed that some of them, although nulliparous, had little fat-body. Probably mammalian blood was

difficult to find, and the flies had grown old and had used up their fat-body without being able to develop eggs. The estimation of the rate of infection with *Onchocerca*, and the value of examining only parous flies for the purpose [*cf.* **47** 190], are briefly discussed.

ARMSTRONG (J. A.), RAMSDALE (C. D.) & RAMAKRISHNA (V.). **Insecticide resistance in *Anopheles gambiae* Giles in Western Sokoto, Northern Nigeria.**—*Ann. trop. Med. Parasit.* **52** no. 3 pp. 247–256, 6 figs., 6 refs. Liverpool, 1958.

A pilot scheme for the eradication from parts of Northern Nigeria of *Anopheles gambiae* Giles, the principal local vector of malaria, by the application of deposit insecticides in houses was begun early in 1954 over an area of some 600 sq. miles to the south-west of Sokoto. The area was divided into three zones, one of which was sprayed every six months from April 1954 with DDT at 200 mg. per sq. ft. and another with γ BHC at 25 mg. per sq. ft. every six months from September 1954 to March 1956, after which the interval between sprayings was reduced to four months. The third was sprayed with dieldrin at 25 mg. per sq. ft. in June and December 1954; it was then noticed that *A. gambiae* was not being controlled, and the dosage of dieldrin was doubled in half the zone, including Birnin Kebbi [*R.A.E.*, B **45** 13–14], for the two 1955 applications. In April 1956, 40 mg. γ BHC per sq. ft. was substituted for dieldrin in this half of the zone, and the dose of dieldrin was raised at the same time from 25 to 50 mg. per sq. ft. in the other half, except in Gwandu, where it was also replaced by γ BHC. An extension zone to the north-east of the original pilot area was treated in May 1956 with γ BHC.

To investigate resistance, bred or wild-caught females from various parts of the treated area and from unsprayed towns were exposed for one hour to filter papers impregnated with oil solutions of dieldrin, DDT or γ BHC, and mortality counts were made 24 hours later. Regression lines were plotted for DDT and γ BHC, and in the case of dieldrin, the proportion of homozygous and heterozygous resistants in the population was determined from the results from two concentrations, 0·5 and 4 per cent. [*cf.* **45** 69], of which the first did not kill any of the heterozygous resistant individuals, and the second killed all except the homozygous resistant ones; the extent and degree of resistance was measured in this way. LC50's of DDT, γ BHC and dieldrin for the unsprayed populations were 0·8, 0·004 and 0·07 per cent., respectively, and all mosquitos died after exposure for one hour to 0·5 per cent. dieldrin. The proportions of the population of *A. gambiae* in the pilot project area (excluding the DDT zone) that were susceptible, heterozygous resistant and homozygous resistant to dieldrin were 9, 2 and 89 per cent., respectively. Corresponding figures for the extension zone, which was first sprayed only 2–3 months before the survey, were 8, 2 and 90, and for Sokoto, which had not been sprayed, 94, 6 and 0. In eight localities in the dieldrin zone, the percentage of females surviving exposure to 4 per cent. dieldrin ranged from 78 to 100 and was generally about 90 or above. In a table, it is shown that exposure to γ BHC resulted in an LC50 approximately 100 times that for *A. gambiae* from the unsprayed areas. The proportions of mosquitos resistant to dieldrin and the LC50's for γ BHC were roughly uniform, irrespective of which had been used, indicating a link between resistance to the two insecticides. There was no indication of resistance to DDT, slightly increased LC50's from the pilot project area outside the DDT zone being attributed to the increased vigour of the resistant mosquitos. The existence of a ' resistance-potential ' was indicated by the fact that

part of the population in areas that had never been sprayed was heterozygous resistant, and it was confirmed by the rapidity with which resistance became established in the extension zone. DDT was the most effective of the three insecticides, *A. gambiae* being present only on the boundary of the zone in which it had been used. The results of the survey showed that there was no relation between the degree of resistance and the density of mosquitos in the sprayed areas.

GILLIES (M. T.). **A modified technique for the age-grading of populations of** *Anopheles gambiae*.—*Ann. trop. Med. Parasit.* **52** no. 3 pp. 261–273, 2 pls., 28 refs. Liverpool, 1958.

Existing methods for the grading of populations of Anopheline mosquitos in age-groups (notably measurement of the ampullae [*R.A.E.*, B **31** 187; **44** 177–178], recognition of qualitative changes in the genital tract [**34** 180; **43** 71–72] and of mating plugs [**46** 205] and the presence of parasitic mites [**46** 191–192]) are reviewed, and it is shown that only those distinguishing parous from nulliparous females are sufficiently exact for practical use. A technique combining three of these methods and recognition of stage of ovarian development [*cf.* **29** 93], as subdivided by Macan according to the amount of yolk visible in the follicle, in a paper already noticed [**39** 55], is described for dividing females of *Anopheles gambiae* Giles into three age-groups. These groups are defined as females taking their first blood-meal and having ovaries from stage I to mid-stage II (yolk readily visible under low magnification), those taking their second blood-meal but having not yet laid eggs and having ovaries in late stage II or stage III (yolk occupying more than half the follicle), and finally those that have already laid eggs at least once. The ovarian stage and presence or absence of mating plugs are first noted, and the females are then divided, so far as possible, into those that are nulliparous (with ampullae not appreciably darker than the paired oviducts, which are narrow throughout their length), and those that are parous (with ampullae distinctly darker and more opaque than the oviducts, which are frequently dilated or collapsed with longitudinal folds). In uncertain specimens that show spermatozoa in the spermatheca but no plug, the ampullae are measured in distilled water. Females with ovaries in stage II are rarely uncertain, and those with stage-III ovaries and ampullae with diameters of >260, 211–260 and <211 μ are classified as parous, intermediate and nulliparous, respectively. However, reference is made in a footnote to a new technique that can be applied to the uncertain specimens and allows the separation of the parous from the nulliparous individuals without measurement of the ampullae. In the first, the currently developing follicle is joined to the internal oviduct of the ovary, either by a loose peritoneal sheath enclosing a slender cord [*cf.* **48** 218] with pigmented thickenings or by an indefinite sac-like sheath, and in the second there is no pigment and the 'stalk' of the ovariole is so short that individual ovarioles can almost be described as sessile. The whole examination is carried out in saline.

The true ages of the groups, as determined by marking, release and recapture experiments in the coastal region of Tanganyika, are, respectively, 1–2 days, 2–3 days and four days and over. Significant differences were found in the age structure of natural populations of *A. gambiae* in the coastal region and in a semi-arid inland region (south Pare District) of Tanganyika, the differences pointing to a shortened life-span inland. Without some indication of the pattern of mortalities among the different age-groups, it is not possible to assess the precise epidemiological significance of the

findings. However, it would seem that the differences in age structure must be at least partly responsible for the striking difference in sporozoite rates in *A. gambiae* on the coast [**24** 193; **43** 71–72] and in south Pare [**47** 111].

Duke (B. O. L.) & Beesley (W. N.). **The vertical distribution of *Simulium damnosum* bites on the human body.**—*Ann. trop. Med. Parasit.* **52** no. 3 pp. 274–281, 1 fig., 5 refs. Liverpool, 1958.

Simulium damnosum Theo. generally bites on the lower parts of the body, and it is in the skin of those parts that microfilariae of *Onchocerca volvulus* are usually concentrated in infected individuals. The authors also found, in their observations in the southern Cameroons, that most palpable onchocercosis nodules were on the same parts. However, among older people in heavily exposed communities, the intensity of individual infections rises, the number of microfilariae in the upper parts of the body increases and sometimes the eyes are invaded and lesions associated with the presence of microfilariae may develop and cause blindness. As the number of microfilariae and adult worms in the upper part of the body would seem likely to rise more rapidly after a small number of infective bites received above the waist than after a large number below it, any factor tending to favour biting on the upper parts of the body over a prolonged period might accelerate the development of ocular lesions. The distribution over the body of bites of *S. damnosum* received by men 5½–6 ft. tall, exposed in different positions and situations, was therefore studied in a riverside clearing in the British Cameroons near sea-level and in a coffee plantation in the French Cameroons at an altitude of 1,500–2,000 ft. The men wore loin-cloths only. Most bites were received immediately above the substrate on which the body appeared to rest, irrespective of anatomical position. A man standing on the ground and one standing on a platform 6 ft. high, both in the open, received at least 98 per cent. of all bites below the waist, as did one sitting in a bosun's chair at a height of 10–20 ft., but the last two received comparatively few bites. A man lying horizontally at ground level on a raffia frame was bitten indiscriminately over the whole body, but men lying feet downwards or head downwards on a similar frame inclined at an angle of 45° received about 10 and 95·5 per cent., respectively, of their bites above the waist. When the men stood waist-deep in grass and bushes, or among chest-high mature coffee bushes or with the head and shoulders protruding through a hole in a platform, up to 15 per cent. of the bites were received on the upper parts of the body. A man standing waist-deep in the river was fairly extensively bitten on the upper parts of the body.

Haddow (A. J.) & Gillett (J. D.). **Laboratory observations on the oviposition-cycle in the mosquito *Taeniorhynchus* (*Coquillettidia*) *fuscopennatus* Theobald.**—*Ann. trop. Med. Parasit.* **52** no. 3 pp. 320–325, 2 graphs, 16 refs. Liverpool, 1958.

The oviposition habits of a mosquito with diurnal biting habits and of one with crepuscular biting habits have been studied and found to be mainly diurnal with a peak of activity in the afternoon [*R.A.E.*, B **46** 192]. The present paper is concerned with the oviposition behaviour of *Mansonia* (*Taeniorhynchus*) *fuscopennata* (Theo.), a night-biting mosquito [**40** 80], as observed in females caught in nature at Entebbe, Uganda, and allowed to engorge on fowl. The mean period between feeding and oviposition was 7·5 days. The oviposition cycle was found to be essentially nocturnal, with

a small peak of activity early in the night and a major peak in the three hours before sunrise. The biting cycle also shows two peaks, but the main one is in the hour after sunset and the smaller in the hour before sunrise. In a discussion of possible connections between the two cycles, it is suggested that the small dawn biting peak is largely due to females that contributed to the small post-sunset peak of oviposition activity, whereas the biting peak after sunset is due largely to the numerous females that had oviposited shortly before sunrise.

Wijers (D. J. B.). **Factors that may influence the infection rate of** *Glossina palpalis* **with** *Trypanosoma gambiense*. **I. The age of the fly at the time of the infected feed.**—*Ann. trop. Med. Parasit.* **52** no. 4 pp. 385–390, 18 refs. Liverpool, 1958.

Experimental work on *Trypanosoma gambiense* and other species of the group of *T. brucei* has been hindered by the low percentage of infection among tsetse flies feeding on infected hosts, and published evidence on factors that may increase the infection rate (such as the form of the trypanosomes [*R.A.E.*, B **46** 191], temperature [**37** 135], host species [**23** 133, 264] or the age of the fly at the time of feeding [**23** 288; **25** 247]) is often conflicting. It appears that flies taking their first meal on the first or second day are much more easily infected than are older ones, but it is not known whether this is due to a biochemical condition in the gut of a hitherto unfed fly or to some event in the development of the peritrophic membrane.

Experiments are described in which adults of *Glossina palpalis* (R.-D.) during the first three days after emergence were given their first feed on monkeys infected with *T. gambiense*, and the relation of the results of these experiments to sleeping sickness in Northern Nigeria is discussed. It is suggested that the peritrophic membrane, the most likely part of the anatomy to hinder trypanosome development, may be weaker and looser in structure just after emergence than it is subsequently, when it forms a barrier to the trypanosome.

Yeo (D.) & Wilson (D. B.). **Aircraft applications for Anopheline control: prevention of a seasonal increase with a granulated formulation of dieldrin.**—*Ann. trop. Med. Parasit.* **52** no. 4 pp. 402–416, 5 figs., 5 refs. Liverpool, 1958.

An account is given of an attempt made in April–June 1956 to prevent the usual seasonal peak of Anopheline breeding at Dar es Salaam, on the Tanganyika coast, by supplementing the established methods of control with applications from aircraft of a granulated formulation containing dieldrin. Granules containing 2 per cent. (w/w) dieldrin were distributed at 1 lb. per acre, seven times over a period of eight weeks, over an area of more than 10 sq. miles. The places thus treated were those that it was most difficult, or in wet years impracticable, to treat from the ground. The characteristics of the material and the mode of application are described. Dosages were very variable, probably mainly because of changes in wind speed and direction. Assessment of effectiveness was difficult because of the other control measures in use and because of unusually heavy, early rain that stopped abruptly. However, examination of breeding places indicated that the formulation was very effective as a larvicide. Catches of females of *Anopheles gambiae* Giles in houses outside but adjacent to the treated areas were reduced to less than one per room within six weeks after the first

treatment, and were in effect nil for some months after that. In areas in which distribution of granules from aircraft was added to the ground control, catches of *A. gambiae* and *A. funestus* Giles were reduced to nil within six weeks (at the beginning of June) and while *A. gambiae* showed some recovery in August, *A. funestus* was virtually eliminated for at least five months. The reduction in the adult population of the two species as a result of the method, as compared with other areas and other years, was estimated to be at least 90 per cent. It is therefore considered that the addition of treatment from aircraft to control from the ground effectively reduced the vector population at the critical period for malaria transmission. The cost of a single application was about twice that of single treatments with the much less effective ground control methods.

Coker (W. Z.). **The inheritance of DDT resistance in** *Aëdes aegypti*.—*Ann. trop. Med. Parasit.* **52** no. 4 pp. 443–455, 4 graphs, 18 refs. Liverpool, 1958.

By mass mating of members of a susceptible strain with members of three DDT-resistant strains of *Aëdes aegypti* (L.) and repeated back-crossing of hybrids, selected by exposing fourth-instar larvae to the minimal lethal dose for the susceptible strain, with that strain and by testing the resistance of the fourth-instar progeny, it was shown that the mode of inheritance in the resistant strains was in every case monofactorial. When resistant strains were crossed with each other, it was found that the resistance factor was probably the same in two of them (Trinidad and Haiti [*R.A.E.*, B **46** 149–150]) and different in the third (Malayan).

Colless (D. H.). **Notes on the Culicine mosquitoes of Singapore. IV. The** *Aëdes niveus* **subgroup (Diptera, Culicidae): introduction and description of five new species and of one new subspecies.**—*Ann. trop. Med. Parasit.* **52** no. 4 pp. 468–483, 8 figs., 14 refs. Liverpool, 1958.

In this fourth paper of a series [*R.A.E.*, B **46** 177], a list is given of the 19 species belonging to the subgroup of *Aëdes niveus* (Ludl.), which include three species and one subspecies (*A. niveus leonis*) here described as new from Singapore and Malaya, one new species from Malaya only and one from Singapore, Sarawak and North Borneo. The recorded distribution of the other species is given.

Potts (W. H.). **Sterilization of tsetse-flies (*Glossina*) by gamma irradiation.**—*Ann. trop. Med. Parasit.* **52** no. 4 pp. 484–499, 15 refs. Liverpool, 1958.

The following is virtually the author's summary. A description is given of the subjection, in England, of pupae of *Glossina morsitans* Westw., collected in Tanganyika, to γ-radiation, and of the maintenance in London of the flies emerging from them. The results, which must be regarded with some reserve since the figures on which they are based are low, may be summarised as follows. Though there is no evidence that pupal mortality was increased by doses of up to 12×10^3 rep (roentgen equivalent physical, representing the energy deposition in water or biological material, as opposed to the roentgen, a measure of energy deposition in air) in pupae that had passed the first third of their development at the time of irradiation, it is likely that there would be an increased mortality in samples containing

younger pupae, and also in samples from which the weaker individuals had not been eliminated by the hazards undergone between collection and irradiation. Mortality was considerably higher at a dose of 3×10^4 rep given at a higher rate. Length of life of the males emerging from irradiated pupae was approximately halved. Mating ability of the males was completely unaffected by irradiation in the pupal stage; they appeared to mate as readily throughout their life as normal males. Complete sterilisation of the males was not effected by irradiation at 6×10^3 rep, and the extent of the residual fertility was of the order of about 20 per cent.; the fertility of the females mated with these males, when they reproduced at all, was only about half that of those mated with normal males, and it is perhaps reasonable to regard the proportion of males not fully sterilised as effectively nearer to 10 than to 20 per cent. The residual fertility of females from pupae irradiated by doses of between 3 and 12×10^3 rep was about 16 per cent., and it is possible that the proportion actually capable of producing viable offspring may not be much more than half this figure. There was also a suggestion that an increase in radiation dose might decrease this proportion.

Teschner (D.). **Die Dipterenfauna an menschlichen Fäkalien. Ein Beitrag zur hygienischen Entomologie.** [The Dipterous fauna of human faeces. A contribution to hygienic entomology.]—*Z. angew. Zool.* **45** pt. 2 pp. 153–199, 12 figs., 45 refs. Berlin, 1958. (With a summary in English.)

The Diptera attracted to human faeces were studied from April to October 1955 in a suburb of Brunswick, principally by means of traps baited daily with fresh samples. A few subsidiary tests were also made with horse dung. In all, 184 species in 85 genera were taken. Lists of them are given, showing their frequency, and the hygienic importance of some of them is discussed. *Musca domestica* L. was not numerous, and when 880 marked individuals of this species were released near two traps baited with faeces, only two were retaken.

Sanger (V. L.). **ET-57 (Trolene) for demodectic mange—a case report.**—*J. Amer. vet. med. Ass.* **132** no. 2 pp. 56–57. Chicago, Ill., 1958.

As it was learned through correspondence that Dow ET-57 [O,O-dimethyl O-2,4,5-trichlorophenyl phosphorothioate] when given orally to dogs infested by *Demodex canis* Leydig at the recommended dose of 100 mg. per kg. of body weight weekly was only moderately successful, larger doses of oral and topical preparations of the chemical were applied simultaneously, in Ohio in 1957, to a 15 lb. dog that was severely infested.

The dog was scrubbed with soap and water and massaged, and when it was dry, every visible lesion was rubbed vigorously with gauze soaked in a 5 per cent. solution of Dow ET-57 until the skin was red, when 2 g. of a 50 per cent. emulsion of the insecticide was given orally in gelatin capsules. The external application was repeated six times in the next 18 days and a further 4·5 g. was given orally. Two dead mites were found in three deep skin scrapings taken 16 days after the first treatment, but three days later, after a warm water bath with a selenium-sulphate solution, no mites were found in six deep skin scrapings from the worst affected areas. The skin lesions were healed, hair grew in all the areas, and the dog had gained 3 lb. in weight. A second bath in the selenium-sulphate solution was given nine

days after the first one, and the dog was sent home. It showed no signs of mange or toxic effect nine weeks later.

Gregson (J. D.). **Tick paralysis in cattle in British Columbia in 1957.**—*Proc. ent. Soc. B.C.* **55** pp. 6–7, 1 fig. Kamloops, B.C., 1958.

The following is substantially the author's summary. In 1957, four outbreaks of paralysis occurred in cattle as a result of attack by *Dermacentor andersoni* Stiles in the Kamloops-Nicola districts of British Columbia. In herds of 300, 118, 700 and 70 yearlings, 10, 32, 320 and 14 animals, respectively, were paralysed, with losses of 3, 7, 30 and 0, respectively. The outbreaks were favoured by a combination of prolonged tick activity and the insufficiency of the protection afforded by BHC sprays applied at inadequate dosages or during showery weather.

Enigk (K.) & Sticinsky (E.). **Die Zwischenwirte der Hühnerbandwürmer** *Raillietina cesticillus*, *Choanotaenia infundibulum* **und** *Hymenolepis carioca*. [The intermediate hosts of the fowl tapeworms, *R. cesticillus*, *C. infundibulum* and *H. carioca*.]—*Z. Parasitenk.* **19** pt. 3 pp. 278–308, 3 figs., 67 refs. Berlin, 1959.

The following is based on the authors' summary. In a study of the intermediate hosts of *Hymenolepis carioca*, *Raillietina cesticillus* and *Choanotaenia infundibulum*, which are important tapeworms of fowls in central Europe, 97 species of arthropods belonging to different classes and orders were repeatedly fed with fresh onchospheres. Species of *Geotrupes*, *Aphodius* and *Sphaeridium* proved to be the principal intermediate hosts of *H. carioca*, species of *Geotrupes* and *Aphodius* and also Carabids of *C. infundibulum*, and *Geotrupes* and Carabids of *R. cesticillus*. Other insects also became infected. Lists of the species are given, and the results are discussed.

Papers noticed by Title only.

Brennan (J. M.). **Synonymy of** *Odontacarus* **Ewing, 1929, and** *Acomatacarus* **Ewing, 1942, with redescriptions of** *O. dentatus* **(Ewing) and** *O. australis* **(Ewing), also descriptions of three new species from southern United States (Acarina: Trombiculidae).**—*Ann. ent. Soc. Amer.* **52** no. 1 pp. 1–6, 3 figs., 17 refs. Washington, D.C., 1959.

Weinbren (M. P.) & Williams (M. C.). **Zika virus:** [two] **further isolations** [from *Aëdes africanus* (Theo.) from Lunyo forest] **in the Zika area** [Uganda], **and some studies on the strains isolated.**—*Trans. R. Soc. trop. Med. Hyg.* **52** no. 3 pp. 263–268, 5 refs. London, 1958. [*Cf. R.A.E.*, B **42** 164; **46** 97.]

Lavoipierre (M. M. J.). **Studies on the host-parasite relationships of filarial nematodes and their arthropod hosts. II. The arthropod as a host to the nematode: a brief appraisal of our present knowledge** [particularly of *Wuchereria* spp. and *Dirofilaria* spp. in mosquitos, *Onchocerca volvulus* in *Simulium* and *Loa loa* in *Chrysops* spp.], **based on a study of the more important literature from 1878 to 1957.**—*Ann. trop. Med. Parasit.* **52** no. 3 pp. 326–345, 4 pp. refs. Liverpool, 1958. [*Cf. R.A.E.*, B **48** 187.]

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